

A
HISTORY OF HINDU CHEMISTRY

FROM

*THE EARLIEST TIMES TO THE MIDDLE OF THE
SIXTEENTH CENTURY A. D.*

WITH

**SANSKRIT TEXTS, VARIANTS, TRANSLATION
AND ILLUSTRATIONS**

BY

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VOL. I

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PREFACE TO THE FIRST EDITION.

Since the days of Sir W. Jones, Sanskrit literature, in almost every department, has been zealously ransacked by scholars, both European and Indian. As the results of their labours we are now in possession of ample facts and data, which enable us to form some idea of the knowledge of the Hindus of old in the fields of Philosophy and Mathematics including Astronomy, Arithmetick, Algebra, Trigonometry and Geometry. Even Medicine has received some share of attention. Wilson in a series of essays published in the *Oriental Magazine* (1823), Royle in his *Antiquity of Hindu Medicine* (1837), and Wise in his commentary on the *Hindu System of Medicine* (1845), were amongst the first to bring to the notice of the European world the contents of the ancient medical works of the Hindus, and recently the Thakur Sahib of Gondal has added his quota. These contributions are, however, of a fragmentary nature. A comprehensive history of Hindu medicine has yet to be written.

Materia Medica has also found, in Uday Chand Dutt, an able exponent. One branch has, however, up till this time, remained entirely neglected—namely, Chemistry. Indeed, it may be assumed that on account of its complex and technical nature it has hitherto repelled investigators.

The progress of chemical knowledge among the ancient nations has always had a fascination for me. The classical works of Thomson, Hoefer and Kopp have been my favourite companions for the last twelve years and more. In the course of my studies in this field I was naturally led to an inquiry into the exact position which India occupies therein, and with this view I undertook a systematic examination, from the chemical standpoint, of the Charaka, the Susruta and the various standard works of the Ayurvedic and Iatro-chemical Periods, which have escaped the ravages of time. It was at this stage that I was brought into communication with M. Berthelot some five years ago—a circumstance which has proved to be a turning-point, if I may so say, in my career as a student of the history of chemistry. The illustrious French savant, the *Doyen* of the chemical world, who has done more than any other person to clear up the sources and trace the progress of chemical science in the West, expressed a strong desire to know all

about the contributions of the Hindus,* and even went the length of making a personal appeal to me to help him with information on the subject. In response to his sacred call I submitted to him, in 1898, a short monograph on Indian alchemy; it was based chiefly on *Rasendrasara Samgraha*, a work which I have since then found to be of minor importance and not calculated to throw much light on the vexed question as to the origin of the Hindu Chemistry. M. Berthelot not only did me the honour of reviewing it at length† but very kindly presented me with a complete set of his monumental work, in three volumes, on the chemistry of the

*"Cependant il serait nécessaire d'examiner certains documents qui m'ont été récemment signalés par une lettre de Rây, professeur à Presidency College (Calcutta). D'après ce savant, il existe des traités d'alchimie, écrits en sanscrit, remontant au XIII^e siècle, et qui renferment des préceptes pour préparer les sulfures de mercure noir et rouge et le calomel employés comme médicaments. Ces indications s'accordent avec celles des alchimistes arabes signalées plus haut. Il est à désirer que ces traités soient soumis à une étude approfondie, pour en déterminer l'origine, probablement attribuable à une tradition persane ou nestorienne."—JOURNAL DES SAVANTS, Oct., 1897.

†"Matériaux pour un chapitre négligé de l'histoire de la Chimie ou contributions à l'Alchimie indienne (Mémoire manuscrit de 43 pages), par Prafulla Chandra Rây, professeur à Presidency College, Calcutta,"—Vide JOURNAL DES SAVANTS, April' 1898

Middle Ages, dealing chiefly with the Arabic and Syrian contributions on the subject, the very existence of which I was not till then aware of. On perusing the contents of these works I was filled with the ambition of supplementing them with one on Hindu Chemistry. Although I have written all along under the inspiration of a mastermind, it is not for a moment pretended that my humble production will at all make an approach to the exemplar set before my eyes

When I first drew up the scheme of the present work, I had deluded myself with the hope of finishing the study of all the available literature on the subject before I took to writing. But I soon found that the task was one of vast magnitude. Some of my friends, whose judgment is entitled to weight, advised me under the circumstances, to curtail the scope of the work as originally planned out, and present a first instalment of it in its necessarily defective and imperfect shape (see Introduction, p. lxxxiv), reserving for a subsequent volume the working-up of the materials which are accumulating from time to time. In the present volume only one or two representative works of the Tantric and Iatro-chemical Periods have been noticed at length.

As regards the transliteration, I have not rigidly adhered to any particular system, but, in the

main, I have followed that of the *Sacred Books of the East*.

Before concluding, I must acknowledge the valuable assistance I have received from Pandit Navakānta Kavibhusana with whom I have toiled through many an obscure passage of the Mss. of the *Tantras*. His sound knowledge of the *Ayurvedas* has also been of much help to me.

* * * *

And now it only remains for me to discharge the grateful duty of expressing my thanks to the Government of Bengal, which at the instance of Mr. Alexander Pedler, F. R. S., Director of Public Instruction, placed a liberal grant at my disposal to enable me to meet various incidental expenses, chiefly in the matter of collecting rare Mss.

PRESIDENCY COLLEGE ·
Calcutta, May 1st, 1902.

}

P. C. RAY.

Word of Regards

Acharya Prafullachandra Ray (1861–1944) is regarded as a maker of modern science in India and also as a science-historian of international repute. Only at the age of twenty four, he introduced himself as one of the finest historian through his essay 'India before and after the mutiny'. Receiving his D.Sc. degree from Edinburgh University, he came back to India and joined Presidency College, Kolkata. In addition to his normal duties, he continued studies in the history of chemistry merely as 'hobby'. He completed the toughest book Kopp's '*Geschichte*' then Udoychand Dutt's '*Materia Medica of the Hindus*' and '*Alchimistes Grecs*' by M. Berthelot. Berthelot's book influenced Ray very much. We may quote few lines from his autobiography '*Life and Experiences of a Bengali Chemist*' which reads as follows :

'About this time I was brought into correspondence with the great French chemist himself. I had occasion to write to him to say that he was evidently not aware that in ancient India also alchemy was zealously pursued and that there are several treatises in Sanskrit on the subject. The reply which my letter elicited is characteristic of the man.....'

It was 1897. Prafullachandra was thirty-six years old. He received a long letter from seventy years old Marcellin Berthelot. A good portion of the letter will be of worth mentioning.

'I have received your chemical researches which are highly interesting and I have seen specially with pleasure how science with its universal and impersonal character is equally cultivated by all the civilised peoples of Asia as well as of Europe and America.

I ask your permission to invite your attention on certain information, you have given relative to the alchemy of India. Perhaps you are not aware of the works in 3 vols. that I have published on the History of Chemistry of the Middle Ages.

1. 1st vol. regarding the transmission of Asiatic Sciences. 2. 2nd vol. regarding Syrian Alchemy and 3. 3rd vol. regarding Arabian Alchemy.'

Berthelot wrote finally that it was Ray's letter which roused his curiosity.

Prafullachandra did not consider his 'hobby' as 'hobby' now. He became serious in his studies. He wrote a paper on the basis of first

few chapters of '*Rasendrasara Samgraha*' and forwarded it to Berthelot. The recipient of the paper elaborated the same in the form of an article and published in the '*Journal des Savants*'. Berthelot also sent all the 'three monumental volumes of his encyclopoedic work' on Syriac, Arabic and middle age alchemies to Ray. The episode reminds us the sending of a historical paper by Satyendranath Bose to Albert Einstein and its subsequent publication in the form of an article in an internationally reputed German Journal. After having all from Berthelot, what kind of reaction occurred in the mind of young P. C. Ray ?

'I greedily devoured the contents of these, and the idea now firmly took hold of me that I must write a history of Hindu Chemistry modelled upon the exemplars before me. I instituted a vigorous search for manuscripts bearing upon the subject and ransacked the pages of Aufrecht's *Catalogus Catalogorum*, Bhandarkar's, Rajendralal Mitra's, H. P. Sastri's and Burnell's Notices of Sanskrit Mss, and put myself in communication with the librarians in India and the India office, London, where some of the manuscripts have been preserved.'

Prafullachandra had a proficiency in Sanskrit but he rightly took the assistance of a Pandit named Navakanta Kavibhusan. Navakanta helped Ray for about five years till the manuscript of '*History of Hindu Chemistry*' (Volume-1) was over.

Prafullachandra wrote an excellent preface which speaks of itself. On the appearance of the book, there was immediate response from the institutions of intellect. The book was reviewed by a large number of journals from abroad and India. Some of them are '*Nature*', '*Journal of the American Chemical Society*', '*Knowledge*', '*The Times of India*', '*The Pioneer*' etc. Berthelot wrote a 15 pages review in the '*Journal des Savants*' (January 1903). '*Knowledge*' mentioned this book 'an instructive selection from the records of Hindu Chemistry (March, 1903)'. The volume was highly acclaimed by Dr. Mahendralal Sircar in his '*Calcutta Journal of Medicine*' (Vol-XXI, 10, October, 1902).

Svante Arrhenius (1859-1927), the Swidish physical chemist and the Nobel Prize recipient of 1903 wrote a book named '*Chemistry in Modern Life*'. Arrhenius quoted a large number of scientific informations from Ray's book.

Archives for the History of Science of Italy made a statement, '.....the capital work of Ray's that will cause his name to be remembered, is the magnificent history of Indian Chemistry from its origins to the middle of the sixteenth century'.

The first edition of the first volume of '*A History of Hindu Chemistry*' was published in the year 1902. The preface contained the date '1st May 1902, Presidency College'. Thus this outstanding work has completed its hundred years of publication. The second edition of the book was readily published after a two years interval in 1904. One can go through the preface of the second edition where Ray mentioned, 'A comparatively limited number of copies was printed in the first edition as it was feared that owing to its technical nature the work would appeal only to a select circle of readers. The exceedingly favourable reception accorded to it not only by the scientists and orientalist but also by the public in general both in Europe and in India has necessitated the bringing-out of a second edition.'

The second volume of '*A History of Hindu Chemistry*' was first published in 1909. The second edition of the same was found in 1925.

The unique excellency of the book is that it is not a mere description of science-history in different periods of India. For the first time, a working scientist made an attempt to understand the reason of decline of scientific spirit in our country. P. C. Ray introduced a separate chapter in its first volume naming 'Knowledge of Technical Arts and Decline of Scientific Spirit' where he clearly analysed 'the real cause of the decline of the scientific spirit in India not within the general framework of science itself but outside it i.e. mainly in the social conditions that developed in this country' (*History of Science and Technology in Ancient India, The Beginnings*, Debiprasad Chattopadhyaya, 1986).

Ray figured out two main factors for the decadance of science and technology in our country. First is the caste system and the second is the overemphasis on mental labour than the manual labour. As an Indian, it is a matter of great pride that this ideology has been later taken into consideration by B. Farrington in his two books '*Greek Science*' (1944) and '*Head and Hand in Ancient Greece*' (1947) and also by Joseph Needham in his multi-volume work '*Science & Civilization in China*'.

We also like to add few more words about this book. Indian Chemical Society, in 1948 resolved that a 'revised edition' of the said book will be published soon. 1954 is the year of publication of the land mark work by J. D. Bernal, '*Science in History*'. Two years later, P. C. Ray's book appeared in a new shape with a completely different name '*History of Chemistry in Ancient and Mediaval India*'. The book was edited by Priyadarajan Ray, a well-known chemist and a favourite student of Acharya P. C. Ray. The cover of the book contained the name Priyadarajan Ray and also the inner authorship owned by him. It is a fact that this new book has added a number of significant informations but it is also a matter of wonder that a good number of points raised by P. C. Ray have been omitted. This kind of revision always poses a question mark so far the ethical issues are concerned. P. C. Ray in Chemical Society's book is only living through 'incorporation'.

We had a dream to publish the original book after a long span of century. It became a reality because Dr. Rabin Bal, the back-bone of Shaibya Prakashan and his son Somnath were aggressive enough to be a part of this historical event. The equation of loss and profit is not always the sole word of a business-the venture is a propagation of this statement.

In fact, this centenary edition is a tribute to Acharya P. C. Ray, the illustrious son of India for his memorable contribution to science and society. This is a facsimile reprint of the two invaluable volumes of '*A History of Hindu Chemistry*'. The first volume is the facsimile of the second edition which was published in 1904. It is because 'some material additions have been made to the historical portion of the introduction, throwing further light on the independent origin of the Hindu system of medicine and its priority to that of the Greeks' (Preface by P. C. Ray, second edition, 1st January 1904).

We hope that this historical book will inspire us to develop a proper concept of science and technology-its prosperity and decadence with rational objectivity.

A HISTORY OF HINDU CHEMISTRY

Volume-I

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Introduction

CHAPTER I

Alchemical Ideas in the Vedas

IN tracing the progress of chemical knowledge among the civilized nations of old, one always finds it intimately associated with medicinal preparations, metallurgical operations, the technical arts and the belief in the transmutation of metals. In India, more so than in Europe, chemistry has, however, been evolved chiefly as a handmaid of medicine ; and, somewhat later on, as an adjunct of the Tantric cult. The efficacy of the drug alone was by no means considered sufficient unless backed by the kindly interposition of the deities. Thus in the *Rigveda* we find the Asvins, the divine physicians, invoked, who give sight to the blind and make the lame walk. These twin gods have many points in common with the Dioskouroi of Greek mythology. One very

Dawn of Hindu
Alchemy.

curious myth is that of the maiden Vispalá who, having had her leg cut off in some conflict, was at once furnished by the Asvins with an iron limb.

The higher gods of the *Rigveda* are almost entirely personifications of the elements and the other natural phenomena, such as the fire and the wind, the sun and the dawn. But we often find also herbs and plants endowed with potent and active properties, raised to the dignities of the gods and addressed as such. The Soma plant is an object of particular adoration and the Vedic worshippers are in ecstasy over the exhilarating effects of the fermented juice expressed from it.¹ The Soma rasa (juice) began even to be regarded as the *amrita*; this immortal draught, allied to the Greek *ambrosia*, is "the stimulant which conferred immortality upon the gods . . . it is medicine for a sick man and the god Soma heals whatever is

1) See Eggeling's Intro. to "Satapatha Bráhmaṇa." Pt. II, pp. 1, *et seq.* also Roth; Ueber den Soma; "Zeit. deut. morg. Ges." XXXV. pp. 680-692; also *ibid*, XXXVIII. 134-139: Wo wächst der Soma? And Windischmann: Ueber den Somacultus der

sick." It will be seen later on that in the Soma rasa and its attributes we have the dawn of Hindu Alchemy (*Vide* p. 79).

Other plants were likewise invoked as divinities. Thus one entire hymn is [devoted to the praise of plants (*oshadhi*) alone, mainly with regard to their healing powers. ¹

Arier : Alhand. d. Münch. AK. d. Wiss. IV. B. Abh. 2.

(1) One or two typical hymns may be quoted here :—

या ओषधीः पूर्वा जाता देवेभ्यस्त्रियुगं पुरा ।

मनौ तु बभूवामहं शतं धामानि सप्त च

शतं वो अन्व धामानि सदृशमुत वो रुहः । X.97.1.

अथा शतकृत्वो यूयमिमं मे अगदं कृत ॥ *ibid.*, 2

Sāyana's commentary to the above is :—

याः ओषधयः पूर्वाः पुरातन्यः जाताः उत्पन्नाः, केभ्यः सकाशात् ? देवेभ्यः ; यद्वा देवाः द्योतमानाः ऋतवः, तेभ्यः । कस्मिन् काले ? त्रियुगं त्रिषु युगेषु प्रादुर्भावापेक्षया कृतादियुगत्रयमुक्तं, कलौ तु अत्यन्ताल्पत्वात् उपेक्षितम् । अथवा त्रिषु युगेषु वसन्ते प्राङ्मुखे शरदि चेत्यर्थः । अहं बभूवौ बभूवर्णां सोमाद्योषधीनां शतं सप्त च धामानि अनुलेपमार्जनाभिवेकादिरूपेण आश्रयभूतानि स्थानानि तु क्षिप्रं मनौ मन्ये संभावयामौत्यर्थः ।

हे अन्व मातरः ओषधयः वो युष्माकं धामानि स्थानानि मन्त्रानि वा शतम् अपरिमितानि ; उतापि च वो युष्माकं रुहः प्ररोहः प्रोदगमः सदृशपरिमितः । अथा अपि च हे शतकृत्वः हे शतकर्मणः यूयमिमं मे मां मदीयं वा जगम् आनययस्वम् अगदं गदः रोगः तदरहितं कृत कुरुत ।

plicity which is the characteristic beauty of the *Rigveda*, one *Rishi* says pathetically of himself :

“ Behold I am a composer of hymns, my father is a physician, my mother grinds corn on stone. We are all engaged in different occupations ‘ ’ (IX. 112, 3),

“ Princes like Divodása, and bards and leaders of the tribe of the Angiras, administered medicines and gloried in effecting cures. A skilled physician is distinctly defined as one who lives in a place abounding with medicinal plants, and who assiduously devotes his time to the acquisition of knowledge ‘.’”

Thus not only in the Atharvan but even in the *Rik*, we can trace the earliest literary record of Indian Medicine.

The “Atharva-veda” deals chiefly with sorcery, witch-craft and demonology. There are deadly imprecations ‘against evil-doers ;

(1) R. C. Dutt : “Civilisation in ancient India,” p. 65 (Calc. ed.)

(2) Introduction to “*Asśāñgahrīdaya*” of Vagbhata, by Anna Morsvar Kunte, B. A., M. D., p. 2.

magical incantations for bringing about ruin, death, dementation and stupefaction of one's adversaries; and charms intended to secure the love of women through the potency of various herbs. Some of them are of hostile character, being meant to injure rivals. The picture here presented has its counterpart in the ancient Egyptians, who were noted for their magical lore to which the Greeks were no less attached. There is a close resemblance between the contents of the A. V. and those of the Papyrus of Leyden in some essential features. In the latter also there is an intermixture of magic, astrology, alchemy as well as recipes for love philters. ¹

The A. V., on account of its frequent calling-in-aid of super-natural agencies for selfish and malevolent purposes, has not generally been accorded the canonical sanctity of the Vedic Triad—The *Rik*, the *Yajus* and the *Sáman*; the very authority of the fourth Veda as a

(1) The reader may compare this portion with Berthelot's "Les Origines de l' Alchimie," pp. 81-83.

scripture has been questioned in the several law-books of the Apastamba, the Vishnu, the Yājñavalkya and the Manu schools, and the practices it sanctions strongly condemned.

As Hindu medicine has seldom been able to shake itself completely free from the influence of magic and alchemy as auxiliaries, physicians; as practicers of the "black art," have been given an inferior position in the legal treatises. The Mahābhārata, reflecting the spirit of the above law-books, regards the physicians as impure. In spite of this "the Atharvan retains in a measure its place by virtue of its profound hold upon popular beliefs, because the Atharvan performs, especially for the king, inestimable services in the injury and overthrow of enemies."

In the A. V., the hymns for the cure of diseases and possession by demons of disease are known as "bhaishajyāni," while those which have for

Rasāyana or Al-
chemy.

(1) Bloomfield's "Hymns of the Atharva-veda":—Introduction, p. XLVI.

their object the sécuring of long life and health are known as "áyushyáni"—a term which later on gave place to rasayana, the Sanskrit equivalent of alchemy (see p. 80). We shall quote two under the latter heading as invocations to pearl and its shell and gold respectively. "Born in the heavens, born in the sea, brought on from the river (Sindhu), this shell, born of gold, is our life-prolonging amulet."

"The bone of the gods turned into pearl; that, animated, dwells in waters. That do I fasten upon thee unto life, lustre, strength, longevity, unto a life lasting a hundred autumns. May the (amulet) of pearl protect thee!"

"The gold which is born from fire,¹ the immortal, they bestowed upon the mortals. He who knows this deserves it: of old age dies he who wears it."

"The gold, (endowed by) the sun with beautiful colour, which the men of yore, rich in descendants, did desire, may it gleaming

(1) Among the five kinds of gold referred to in the "Rasaratna-amuch chaya" (p. 10) वज्रकुम्भ (born from fire) is one.

envelop thee in lustre ! Long-lived becomes he who wears it ! ”

While gold is regarded as the elixir of life, lead is looked upon as the dispeller of sorcery: “ To the lead Varuna gives blessing, to the lead Agni gives help. Indra gave me the lead ; unfailingly it dispels sorcery.”

It is of interest to note the alchemical notions which had gathered round gold and lead^a at the time of the A. V.

To the student of Hindu medicine and alchemy, the A. V. is thus of special interest as the earliest repository of information on the subject.

(1) The quotations are from Bloomfield's A. V. pp. 62-65.

(2) In the alchemy of the West, lead, as is well known, is associated not with beneficent but “Saturnine” influence.

CHAPTER II

The Ayurvedic Period

We now alight upon a period when we find the Hindu system of medicine methodised and arranged on a rational basis, with a scientific terminology.

The two great works of this period are the Charaka and the Susruta. In them we find the study of the subject to have made a distinct advance and to have been evolved out of the chaotic state it was in during the Vedic period. Of the two, the Charaka is by far the more ancient. ¹

There must have been a wide gap between the age of the A. V. and that of the Charaka—an interval of probably a thousand years or more.

(1) Cf. "The theological doctrine of the nature of disease indicated its means of cure. For Hippocrates was reserved the great glory of destroying them both, replacing them by more practical and

In the latter the humoral pathology is fully developed, the diagnosis and prognosis of diseases described at length, and an elaborate mode of classification adopted. We have seen above that the physicians were assigned rather an inferior status in society; the healing art was, in fact, never recognised as a division of the Vedas.¹ Still the claims of the indispensable science of medicine, which can be distinctly traced to the A. V., could not altogether be ignored, and ultimately a compromise was arrived at. In the Charaka itself the Science of Life

material ideas, and, from the votive tablets, traditions, and other sources, together with his own admirable observations, compiling a body of medicine. The necessary consequence of his great success was the separation of the pursuits of the physician from those of the priest. Not that so great a revolution, implying the diversion of profitable gains from the ancient channel, could have been accomplished without a struggle. We should reverence the memory of Hippocrates for the complete manner in which he effected that object."—Draper's "Hist. of the Intellect. Dev. in Europe," I. p. 393 (ed. 1896). The services rendered by Charaka, Susruta and their predecessors were equally valuable.

(1) The six *limbs* or divisions of the Vedas are *sikshá* (phonetics), *kalpa* (ceremonial), *vyākaraṇa* (grammar), *nirukta* (etymology), *chhandas* (metre) and *jyotisha* (astronomy).

(*Āyurveda*) is regarded as a secondary or subsidiary branch (*upāṅga*) of the Atharvan and as a direct revelation of the gods (*Sūtra* : Ch. XXX. 8-9).

The *Susruta* even goes a step further and asserts that the self-existent (*Brahmá*) created *Āyurveda*, as an *upāṅga* of the Atharvan (*sūtra* : 1. 3.)

We shall now concern ourselves with finding the time of Charaka within approximate limits. The task is not a light one, and it is one of the most abstruse questions of Indian chronology.

M. Sylvain Lévi has recently unearthed from the Chinese Tripitaka the name of a physician named Charaka, who was attached as spiritual guide to the Indo-Scythian King Kanishka, who reigned in the second century A. D. The French Orientalist would have this Charaka as the author of the famous Hindu medical work, specially as it would offer an easy explanation of the supposed Greek influence discernible in it.

“Les éléments traditionnels mis en œuvre par les conteurs peuvent se résumer ainsi : le roi devaputra Kanishka, de la race des Kushanas, règne sur les Yuetchi, sept cents ans après le Nirvāṇa ; il est assisté de ministres éminents, nommés Devadharmas et Mātharas. Le bodhisattva Asvaghosha est son conseiller spirituel ; l'illustre médecin Charakā est attaché à sa personne.”

* * * *

“La mention de Charaka est la première indication positive obtenue sur la date du savant praticien qui dispute à Susruta la gloire d'avoir fondé la science médicale dans l'Inde. Les influences grecques qu'on avait cru reconnaître dans les doctrines de Charaka s'expliquent aisément, s'il est vrai que ce grand médecin vivait au temps et à la cour des Indo-Scythes, alors que l'hellénisme semblait pénétrer en vainqueur dans la vieille civilisation brahmanique.”

——“Journ. Asiatique” (1896), T. VIII. pp. 447-51

We confess we are by no means convinced of M. Lévi's theory. If we are to go by *name* alone, we can claim a still higher antiquity for our author. The appellation of Charaka occurs in Vedic literature as a patronymic ; in short, Pāṇini felt it necessary to

compose a special sūtra for deriving the "Charakás" i.e. the followers of Charaka.¹ Then again, Patañjali, who is now generally admitted to have lived in the second century B. C., is known to have written a commentary on the medical work of Charaka, thus further proving the antiquity of our author;² and both Chakrapáni and Bhoja agree in alluding to him as the redactor of Charaka.³ Indeed, in such matters we would do well to set store by native traditions. It would be beside our purpose, however, to enter into any lengthy discussion on the grounds on which we are inclined to place Charaka in the pre-Buddhistic era, but we shall summarise below the salient points.

(1) कठचरकास्तुक् । 4. 3. 107.

(2) चास्ती नाम अमुभवेन वस्तुतत्त्वस्य कारकैर्गुण निश्चयवान्, रागादिवशादपि नात्यसावादी यः स इति चरके पतञ्जलिः । Quoted in the "Laghu Mañjushá" of Nágesa Bhaṭṭa.

(3) पातञ्जल-महाभाष्य-चरकप्रतिसंस्कृतेः ।

मनोवाक्-कायदीवाणां हर्षोऽहिपतये नमः ॥

Vide salutation in the commentary named आयुर्वेददीपिका on the Charaka by Chakrapáni.

In the handling of the subject-matter the Charaka is not so systematic ^{Evidence based upon the handling of the subject-matter,} as the Susruta, but indulges in random, hap-hazard and irrelevant discourses, which make the reader often lose the thread of the main narrative. The author, whenever he has an opportunity, boldly and with evident relish, launches into metaphysical disquisitions, which, he believes, make up for lack of experiments and observations.¹ In this respect the Susruta is far more scientific than the Charaka. The Nyāya and the Vaiseshika systems of philosophy, which have been interwoven into the body of the text, again remind us of a stage when they were more or less in a state of flux, but had not crystallised into the well-defined form and shape of the sūtras in which they have come down to us—this also

(1) This has given ample scope to a recent commentator, the late Kavirāja Gangādhara Kaviratna, who in his अल्पकल्पतरु, surpasses Charaka himself in philosophical dissertations.

goes towards proving the high antiquity of the Charaka. ¹

Again, only Vedic gods and mantras figure in the Charaka, not a trace of Paurāṇic mythology being discernible in it. ² Charaka follows closely the Vedic authority ³ in counting the number of bones in the human body; the

(1) The Nyāya of Gotama enumerates 16 padārthas (categories), while Charaka under his (medical) disputation, चार्दनाग, mentions 44 categories (Vide Vimāna. Ch. VIII. 22., also A. C. Kaviratna's Eng. trans. pp. 564-65). Bodas in his learned Introduction to the Tarkasamgraha of Annambhatta (pp. 12-14) places the aphorisms of Gotama and Kanada in the period between 400 B. C. to 500 A. D.

(2) The names of Krishna and Vāsudeva occur in a salutation in the supplement added by Dridhavalā. Chikitsita. Ch. 21. 92-93. ed. Gaṅgādhara). But Krishna-worship was in vogue at the time of Pāṇini; 4. 3. 98. See also Lassen's Alterthumskunde 1. p. 648. Bühler also points out that "the earlier history of the purāṇas, which as yet is a mystery, will only be cleared up when a real history of the orthodox Hindu sects, especially of the Sivites and Vishṇuites, has been written. It will, then, probably become apparent that the origin of these sects reaches back far beyond the rise of Buddhism and Jainism."—Intro. to "Apastamba," &c. p. XXIX..

(3) Namely 360; Sārīra. Ch. VII, 5. According to the Institutes of Vishṇu "it (the human frame) is kept together by three

limit of childhood he takes to be thirty years—quite in keeping with the conception of the heroic age.

It should, however, be borne in mind that the Charaka, as we now possess it, can by no means lay claim to be the first comprehensive and systematic treatise on Hindu medicine, it represents rather a more or less final development of the subject, just as the elaborate grammar of Pāṇini is based upon some twenty previous works of his predecessors, notably of Yāska, Śākalya, Śākatāyana, Gārgya and others.

The above has its parallel in the history of Græek medicine anterior to the time of Hippocrates. As Draper observes :

“Of the works attributed to Hippocrates, many are doubtless the production of his family, his descendants, or his pupils. The inducements to literary forgery in the times of the Ptolemies, who paid very high prices

hundred and sixty bones” (XCVI. 55). This has been adduced by Jolly as a “reason in favour of the high antiquity of its laws.” Vide Intro. to Vishṇu, pp. XVIII-XX. See also Jolly’s “Medicine” (Grundriss), p. 42.

for books of reputation, have been the cause of much difficulty among critics in determining such questions of authorship. The works indisputably written by Hippocrates display an extent of knowledge answering to the authority of his name ; his vivid descriptions have never been excelled, if indeed they have ever been equalled. The Hippocratic face of the dying is still retained in our medical treatises in the original terms, without any improvement. ”

Still more appropriate are the remarks of Litré on the works which now bear the name of “the father of medicine.”

“Lorsqu’on recherche l’histoire de la médecine et les commencements de la science, le premier corps de doctrine que l’on rencontre, est la collection d’écrits connue sous le nom d’œuvres d’Hippocrate. La science remonte directement à cette origine et s’y arrête. Ce n’est pas qu’elle n’eût été cultivée antérieurement, et qu’elle n’eût donné lieu à des productions même nombreuses ; mais tout ce qui avait été fait avant le médecin de Cos a péri. Il ne nous en reste que des fragments épars et sans coordination ; seuls, les ouvrages hippocratiques ont échappé à la destruction ; et, par une circonstance assez singulière, il existe une grande lacune après eux, comme il en existait une avant eux : les

travaux des médecins, d'Hippocrate à l'établissement de l'école d'Alexandrie, ceux de cette école même ont péri complètement, à part des citations et des passages conservés dans des écrivains postérieurs; de telle sorte que les écrits hippocratiques demeurent isolés au milieu des débris de l'antique littérature médicale.

Of internal evidence the first notable, and internal evidence. feature is the style.

The simple, unvarnished prose of the Charaka reminds one of the Bráhmaṇas of the Vedas. Thanks to the researches of Bühler and Fleet, we have now some idea of the prose Kábya style as it existed in the second century A. D. The literary prose inscriptions discovered at Girnár and Násik, although less ornate and artificial than the romances of Subandhu and Vána (seventh century A. D)., abound in long-winded metaphors and alliterations and thus stand in bold contrast with the simple prose of the Charaka.

Between the period of the A. V. and that of the Charaka there must have been com-

posed several medical treatises, each reflecting the spirit, and progress of its age¹. At the time of the Charaka itself there existed at least six standard works by Agnivesa, Bhela, Játukarṇa, Parásara, Háríta, and Kshárapáni, respectively. Charaka simply based his work on that of Agnivesa², which he completely recast and remodelled. Later on, *Dridhavalá* added the last forty-one chapters³. The other five works seem to have perished⁴. Vágbhata,

(1) We are at present engaged in examining the Bráhmaṇas, the Upanishadas and Buddhistic literature with a view to glean information on these points and hope to announce the results in the second volume.

(2) Charaka himself naively assigns his reasons for giving preference to the treatise of Agnivesa in the words :—"of the six (authors) Agnivesa was the most "sharp of intellect" (sútra Ch. I 2.)

(3) विज्ञादयति लेशीकं सङ्ग्रहयति विज्ञानम् ।

संस्कृतां कुरुते तन्मं पुराणेषु पुनर्मयम् ॥ Siddhi. Ch. XII. 28.

Also Chikitsita, Ch. XXX. 112 ; ed. D. N. Sen and U. N. Sen.

(4) Cf. "We know how often in India the appearance of a convenient abstract has led to the neglect and subsequent loss of all earlier works on the subject."—Intro. to Stein's *Rājatarāṅginī*, p. 25. In Burnell's Tanjore catalogue Pt. I. pp. 63-65, a full analysis is given of *Bhelasamhita*, from which it would appear that this work is still extant, though in a mutilated form. Dr. Burnell

the epitomiser of the Charaka and the Susruta, mentions the works of Háríta and Bhela, which were probably extant in his days.

On reading the Charaka, one often feels as if it embodies the deliberations of an international Congress of medical experts, held in the Himálayan regions to which even distant Balkh (Bactriana) sent a representative in the person of Kámkháyaṇa (see p. 25). The work professes to be more or less of the nature of a record of the Proceedings of such a Congress.¹

Bodas in discussing the philosophical disquisitions of the Bráhmaṇas observes :

"It was a special function of the Brahmá priest to give decisions on any disputed points that may

remarks; "the most superficial comparison shows how much Vágbhaṭa was indebted to this ancient work."

An "Háríta Samhitá has recently been published; but its authenticity is questionable.

(1) Cf. 'La lecture de cet ouvrage nous initie aux comptendus de véritables congrès philisophiques et médicaux, dans lesquels des maitres accourus des points les plus éloignés de l'Inde et même de l'étranger, prennent successivement la parole.'—Quelques Données Nouvelles a propos des Traités médicaux Sanscrits antérieurs au XIIIe siècle, par P. Cordier, p. 3.

arise in the course of a sacrifice, and this he could not have done unless he was a master of ratiocination. Such decisions, which may be likened to the chairman's rulings in a modern assembly, are scattered through the ancient Brāhmanas, and are collected together as so many Nyāyas in the Pūrva Mīmamsa aphorisms of Jaimini." ¹

We would invite the reader to go through the "Discourse on the Tastes" (pp. 25-28) and he will naturally agree that the above remarks apply with equal force to our author. In short, judging both from the manner and the matter of the work, we have little hesitation in placing it in the pre-Buddhistic era. We shall revert to the subject under Susruta.

As regards the Susruta we are on more solid grounds. Its terminology and *technique*, in general, do not differ much from those of the Charaka. In style the Susruta is rather dry, pithy, laconic, and matter-of-fact, as the Charaka is discursive and diffuse, and its composition altogether would point to a much later date.

(1) In.ro. to Annambhatta's Tarkasamgraha, p. 28.

This is easily accounted for. The Susruta, such as has been preserved to us, is generally held to be a comparatively modern recension by the celebrated Buddhist Chemist, Nágárjuna,¹ who is said to have added the Uttaratantra or the Supplement.² Here for the first time in the history of Hindu Medicine and Chemistry, we come accross a personage who is historical rather than mythical (see below). That the redactor thoroughly recast and remodelled the Susruta is evident from the fact that there are numerous passages in it which agree almost *verbatim* with the Charaka, and which appears to have been amply laid under contribution.

(1) "यच्च यच्च परोक्षे नियोगस्तच्च तत्रैव प्रतिसंस्कारं सूत्रं ज्ञातव्यमिति

प्रतिसंस्कारापीड नावाच्यं एव "Vide Dalvana's commentary.

(2) Cf. "It is said by Dalvanáchárya, the commentator of Susruta, that at the time of war between the Bauddhas and Hindus, the Susrutatantra was re-edited and rendered more comprehensive by the renowned chemist Siddhanágárjuna with a supplement called "uttaratantra." Since that period it has been known by the name of Susruta Samhita." Introduction to "Vaidyakasabdasinghu" p. 6. by Kavirája Umesachandra Gupta Kaviratna.

The Susruta is *par excellence* a treatise on surgery¹ as the Chāraka is on medicine proper. Ancient India must have acquired considerable skill in the handling of the lancet; for in the Charaka we find a distinction drawn between the “Káyachikitsakas,” *i. e.* the physicians properly so called, and the “Dhanvantvarisampradáyas” *i. e.* followers of Dhanvantvarí or the Chirurgeons—a distinction which we have already noticed in the beginning of the Vedic Age.

The age of Susruta has been the subject of animated controversy for a long time past. The Hindus regard this branch of Ayurveda as a direct revelation from the Asvins or the Divine Surgeons (see p. i, Intro.). The origin of this myth can be traced to the *Rigveda* as already seen. In the *Mahábhárata*, Susruta is spoken of as the son of the sage Visvámitra and in the “Várttikas” of Kátyáyana (about 4th century B. C.) we

(1) For a description of the surgical instruments together with their drawings, see Wise: “Commentary on the Hindu System of Medicine, (1845) pp. 168-170.

also find mention of the same name. It is not, however, easy to establish any connection between these names and our present author. That there was a *Vṛiddha* (old) *Susruta*, existing as early as the fifth century A. D., has now been established almost beyond doubt. Dr. Hoernle, to whose profound scholarship and indefatigable labours the world is indebted for the excellent edition of the Bower Ms., has deduced from palæographic evidence that it must have been copied within the period from about 400 A. D. to 500 A. D. '—a conclusion at which Prof. Bühler has independently arrived. The work professes to be by *Susruta*, to whom it was declared by the Muni *Kásirāja*. The origin of the *Ayurveda* as given in the Bower Ms., is on much the same lines as in the *Charaka* and the mention in it, among others, of such names as *Hárita*, *Bhela*, *Parásara*, and the *Asvins* as founders of the science of medicine, would go to prove

(1) On the date of the Bower Ms., See "Journ. As. Soc."

that even so early as the 5th century A. D., the old Susruta had come to be regarded as of mythical origin, and that therefore it must have been composed many centuries anterior to that time. Several important recipes as given in the Bower Ms., *e. g.* those of the "chyavānaprāsa," "silājatuprayoga" (the doctrine of bitumen p. 53) etc., occur in practically identical recensions in the Charaka. This is easily accounted for. The Charaka, the Susruta, and the Bower Ms., and even the *Ashāṅgahrīdaya* of Vāgbhaṭa have more or less a common basis or substratum. In order to understand this point more clearly it is only necessary to refer for a moment to the legal literature of the Hindus. The "Mānava Dharmasāstra" or the Institutes of Manu, which still exercises a potent influence in the regulation of the social life of the Hindus, is by no means the ancient work that it pretends to be. Modern research has shown that it is only a recension, or rather a recension of a recension, of "Dharmasūtras" connected with the Vedic Schools, incorpora

ting at the same time the laws and usages of the age at which it was remodelled.'

It would equally be a great mistake to suppose that the knowledge—chemical and therapeutical—which our Susruta embodies is only representative of the time of its final redaction. As a matter of fact it is a repository of the informations on the subject accumulated from the Vedic age to the date of its final recasting.

The remarks of M. Berthelot regarding a Greek technical treatise, which, from palæographic evidence, seems to have been written about the 11th century A. D., apply with still greater force to the Susruta.

"En effet la date de rédaction originelle n'est certainement pas le même pour les divers articles que le traité renferme : les uns étant plus anciens et remontant parfois jusqu'à l'antiquité gréco-Egyptienne ; tandis que les autres reproduisent des recettes postérieures et des additions peut-être contemporaines du dernier copiste. En tous cas, ce traité continue la vieille tradition de l'orfèvrerie

(1) Vide Bühler's Introduction to "the Laws of Manu" : pp. XVIII et seq. "Sacred Books of the East," Vol. XXV.

alchimique, qui remonte aux anciens Egyptiens."—
 "Coll. des anciens alch. Grecs.," t. iii., trad. p. 307.

The period when the Susruta received its final cast must always remain an open question. Vāgbhaṭa in his *Ashtāṅgahrīdaya* makes copious extracts both from the Charaka and the Susruta. The latter must therefore have existed in their present form prior to the 9th century A. D. Mādhavakara in his *Nidāna* quotes bodily from the *Uttaratantra*, and as the *Nidāna* was one of the medical works which were translated for the Caliphs of Bagdad (see below), it can safely be placed in the 8th century at the latest. It is thus evident that the present redaction of the Susruta must have existed anterior to that date, and that it had become at that age stereotyped as it were. The Vāgbhaṭa and the *Nidāna* are simply summaries of the Charaka and Susruta,¹ and were written at a time when

(1) This statement we make in a qualified sense, and we fully agree with Roth when he observes "Udoy Chand Dutt in seiner *Mat. Med.* bezeichnet das Werk als eine methodische geordnete Compilation aus Charaka und Susruta. Ich glaube er thut ihm damit Unrecht: Vāgbhaṭa der sich übrigens mehr an

the latter had become very old, and were therefore studied by few experts, and their abstracts were likely to be prized by the general practitioners.

Vágbhata concludes his masterly treatise with the following observation, which is highly significant :—

“ If a work is to pass current as authoritative simply because it is the production of a sage of old, why are the treatises of Charaka and Susruta alone studied and not those of Bhela and others ? It thus follows that whatever is reasonable [methodical and scientific] is to be preferred.”²

Read between the lines the above is to be taken as an apology on the part of our author for appearing in the field ; it further establishes clearly that even during his life-

Susruta hält, ist nicht so unselbständig.” “ Zeit. deut. morg. Ges.” 49. p. 184.

(1) e.g. Játukarna, Parásara, Kshárapáni, etc. see p. xxi.

(2) अविप्रचीते प्रीतिसेन्मुक्ता चरकसन्नुतो ।

मिकायाः किं न पद्यान्ते तस्यादद्यात् सुभाषितम् ।”

time the Charaka and the Susruta were regarded as *hoary with the prescription of age*, and their memories had passed into the region of tradition.¹

The earliest commentary of the Susruta that has been partially preserved to us is known as the Bhānumati by Chakrapāṇi Datta, the celebrated author of the medical work which goes by his name (about 1060 A. D.). The other well-known commentary, the Nibandha Samgraha, is by Dalvana, who lived in the reign of Sahanapāla Deva whose kingdom was situated somewhere near Muttra. Dalvana acknowledges his obligations to the previous commentators, namely Jejjata, Gayadāsa, Bhāskara, and Mādhava whose dates it is not easy to ascertain.

Since a remote period the text of the Susruta has been jealously preserved and no tampering with it tolerated. Thus Dalvana refuses to

The commenta-
tors of Susruta.

The purity of the
text.

(1) On the age of Vāgbhaṭa see below under its proper heading.

recognise the authenticity of a passage, because an ancient commentator, Jejjata, has not noticed it.¹

We have been at some pains in arriving at an approximate age of the composition of the Susruta, because attempts have been made now and then by a certain school of European scholars to prove that the medical works of the Hindus are of comparatively recent date. Haas has propounded the bold and astounding theory that the systematic development of Hindu medicine took place between the tenth and sixteenth centuries A. D.² We

(1) चनार्थोऽयं योगः. जेज्जटाचार्येण नीकत्वात् । तस्मान्न पठनीयम् ।

Chikitsita. VII. 3.

Many such instances may be cited. For the purity of the text we are much indebted to these commentators.

(2) Kehren wir nunmehr wieder zur historischen Frage zurück, so können wir jetzt einen Anfangs—und einen Endpunkt aufstellen, zwischen welche wir mit einiger Sicherheit das Entstehen der systematischen Wissenschaft der Medizin bei den Indiern verlegen müssen, nämlich den Zeitraum von der Mitte des 10. bis Zur Mitte des 15. Jahrhunderts.—“Ueber die Ursprünge der Indischen Medizin, mit besonderem Bezug auf Susruta.” “Zeit. deut. morg. Ges.” XXX. p. 642.

shall see later on that this is precisely the period which marks the *decadence* of the Hindu intellect in the field of medicine and mathematics.¹ We should not have thought it necessary to discuss seriously the various arguments which Haas adduces in support of his views, some of which Dr. Hoernle curtly disposes of as "an elaborate joke," were it not for the fact that this German critic represents a school which cannot or will not see anything in India, which can claim originality or antiquity. In his blind zeal to support this theory, Haas has been led into the most egregious blunders. He comes to the strange conclusion that the works of Vāgbhata, Mādhava and Śārṅgadhara and others supply the germs, out of which the Charaka and Susruta have been elaborated, forgetting or ignoring that the former repeatedly and gratefully acknowledge their indebtedness to the latter.

(1) *Vide* "Decline of Scientific Spirit" pp. 190-198.

Haas is anxious to prove that the Hindus and the origin of Indian medicine borrowed their notions of humoral pathology from the Greeks, and that the *origines* of Indian Medicine are to be looked for in the writings of Galen and Hippocrates; indeed he goes so far as to suggest that the very name of Susruta is derived from the Arabic word Sukrat (=Sokrates), which is often confounded with Bukrat; the Arabic corruption of the Greek Hippocrates.¹ There is certainly a strange similarity between the chapter on "Initiation" in the Charāka and the "Eides" of Æsculapius as pointed out by Roth,² and there is also much in common between the doctrine of humoral pathology of

(1) No less preposterous is the etymology of Kāśf (Benares), which Haas derives from Kos, the native place of Hippocrates.

(2) "Indische Medicin: Charaka," Z., D. M. G., Vol. 26. p. 441. Roth, whose knowledge of the Vedic and, to a certain extent, of the Ayurvedic, literature was encyclopedic, simply points out the analogy and stops short there. M. Liétard, who evidently borrows his information from Roth's article, jumps at once to the conclusion that the Hindus owe their inspiration to the Greeks!—Bull. de l'Acad. de Méd. Paris, May 5, 1896 and May 12, 1897.

the Greeks and the Hindus respectively—suggesting that borrowing may have taken place on one side or the other. But the Hindus would seem to have priority of time in their favour.

The doctrine of humoral pathology or at any rate the first beginnings of humoral pathology. of it can be traced so far back as the time of the *Rigveda*.¹

In the Atharva-veda, which may be looked upon as the parent of the Ayurveda, we naturally come across ample evidences of an ingrained belief in the causation of diseases by the disturbance of the humors. Thus we have such terms as “*Vátīkrīta*,” *i.e.* a disease brought on by the derangement of the humor “*Vāta*” (wind or air), “*Vātagulmin*,” &c.²

(1) * * * विधातुं शर्मं वृद्धं शुभस्यती ॥ I. 34. 5.

Sāyana's commentary to the above :—

हे शुभस्यती ब्राह्मणस्य श्रीवधजातस्य पातकी युवां विधातुं वात-
पित्तश्लेष्मजननविषयं शर्मं सुखं वृद्धं प्रापयतम् ।

(2) This has been lately pointed out by Jolly (“*Medicine*” p. 41) : The discussion on the term quoted above is so very important that we think it desirable to quote it at length :—

Early Buddhist literature also furnishes
 pre-Budhistic us with abundant proofs of
 in origin. this nature. On going
 through the chapter on "Medicaments" in
 the Mahāvagga, we are often reminded of
 the contents of the Susruta.¹ From Pāṇini

"The history of the interpretation of this hymn is of uncommon interest, because it illustrates forcibly the particular closeness of relation between the hymns of the Atharvan and the practices reported in connection with them. Professor Weber, *Indische Studien*, IV, p. 405, translated the hymn under the caption 'Gegen hitziges fieber,' and guided especially by the more immediate meaning of *garāyugāh*, 'the product of the placenta, after-birth,' he thought that the hymn referred to puerperal fever, or the fever of a child. Ludwig, *Der Rigveda*, III, p. 343, surmised that the hymn was directed against inflammation, and Zimmer, *Altindisches Leben*, p. 390, refers to it in connection with the word *vāta* in the first stanza, which he would translate by 'wound;' he also identifies *vāta* with 'wound' etymologically. The compound *vātabhrāgās* in the first stanza, as he understands, means 'suffering from wound-fever.' But Zimmer's theory that the word *vāta* ever means 'wound' has not sustained itself: *vāta* is 'wind in the body;' *vātikṛitanāsanī* (VI,44,3¹) is 'destroyer of the disease which comes from wind (of the body)'; cf. *bāta byādhi* (*vātavyādhi*), 'diseases produced by wind (in the body),' in Wise's *Hindu System of Medicine*, p. 250, and see *Contributions*, Fourth Series, *Amer. Journ. Phil.* XII, p. 427." Bloomfield's *A. V.* p. 246.

(1) One or two instances may be quoted here:—"Now at that time a certain Bhikkhu had a superfluity of humors in his body"
 —*Vinaya Texts*: pt. II. p. 60.

also we can glean technical terms as used in the Ayurveda, suggesting that a system of medicine existed in his life-time.¹

We have thus what amounts to positive historical evidence that during the life-time of Buddha and even much earlier the doctrine of humoral pathology and the Ayurvedic method of

Positive historical evidence.

"And the blessed one said to the venerable Ānanda: 'A disturbance, Ānanda, has befallen the humors of the Thathāgata's body'—*ibid.*, p. 191.

The various kinds of salts used in medicine as also the eye ointments, to wit, black collyrium [stibium], rasa ointment [rasāñjana], sota ointment [srotāñjana] &c. *ibid.* p. 90, are exactly the same as prescribed in the Susruta and other works on Hindu Medicine. (See also under añjanas, p. 93 of this book).

Note specially the reference to *vatthikamma* which is a Pāli corruption of the Sanskrit *vastikarma*:

"Now at that time the Chhabbaggiya Bhikkhus, since a surgical operation had been forbidden by the Blessed One, used a clyster."

No body has yet been bold enough to suggest that in the Mahāvagga Greek influence can be traced.

(1) The very terms Ayurveda and Ayurvedika *i.e.* expert in the Ayurveda occur in Pāṇini. We give below a list of some of the technical terms.

शिशुकन्दयमसमहन्देन्द्रजमनादिभ्यः ४।१.८८ ; परिनायनसमसंज्ञा-
भाष्योः ३।१.१३ ; ख्यायोः प्राचाम् ५ ४ १०० ; ख्यायो ईकन् ५ १।१३ ;

treatment were in vogue.¹

In the Vārttikas of Kātyāyana also (4th to 3rd century B. C.) the three humours of vāta (air), pitta (bile) and sleshman (phlegm) are ranked together.

Regarding the age of the Vinaya Text, Rhys Davids and Oldenburg say :

“The Vibhanga and the Twenty Khandhakas were at that time (circa 350 B. C.) already held in such high repute that no one ventured to alter

आदकाचितपात्रान् स्त्रीऽन्यतरस्याम् ५ १५३ ; लोमादिपामादिपिच्छादिभ्यः
शनेलचः ५ २ १०० ; सिष्णादिभ्यश्च ५ २ १२३ ; रोमाश्चापनयने ५ ४ ४२ ;
कालप्रयोजनादरीगे ५ १ १८१ ; अर्श आदिभ्योऽच् ५ १ १२३ ; रोमाख्यायां
खुल् बहुलम् ३ ३ १०८ ; कषादिभ्यष्ठञ् ४ ४ १०२ ।

(1) The Jīvaka Komārabhachcha, who treats Buddha, derives his surname from “kaumārabhṛitya,” a technical term for one of the eight divisions (astāngas) of Ayurveda, meaning *treatment of infants*. Vide the Mahāvagga, pt. 11, p. 174.

In Asvaghosha's “Life of Buddha” we also read : “Atri, the Rishi, not understanding the sectional treatise on medicine, afterwards begat Atreya, who was able to control diseases.”—Beal's trans. p. 11. This Atreya (Punarvasu) may have been the same sage who taught Agnivesa.

(2) Webér's “Hist. Sanks. Lit.” p. 266, Eng. trans, ed. 1892.

them; a sanctity of this kind is not acquired without the lapse of a considerable time: and we think it is not going too far to say, Firstly, that these books must have been in existence, as we now have them, within thirty years, earlier or later, of, at least, 360 or 370 B. C." (Intro. p. xxiii).

It is therefore evident that almost before the birth of Hippocrates, the Hindus had elaborated a system of medicine based upon the humoral pathology. And yet Hass would have it that the Greeks, in the field of medicine as in several others, were the "pioneers and the first teachers of the world."

M Liétard very justly observes that if it could be proved that the doctrine of humoral

(1) "Wenn aber einmal der Boden von der Vorstellung geräumt ist, dass die Araber den Susruta und Charaka schon im 9. Jahrh. gekannt haben müssen, und wenn auf der andern Seite sich herausstellte, dass die Theorien der indischen Autoritäten in ihren Grundzügen mit denen des Galen übereinstimmten, so stünde nichts der Annahme im Wege, dass auch auf diesem Felde, wie auf so vielen andern die Griechen wieder das bahnbrechende Volk und die ersten Lehrmeister der Welt gewesen sind":—Z. D. M. G. Vol. 30. p. 670.

pathology was broached in India anterior to the time of Hippocrates, not only would the originality of the Hindus be established, but that of the Greeks would be compromised thereby.¹ The question may therefore be now taken as settled for good.

The capacity of a nation must be judged by what it has independently achieved in the several fields of knowledge and branches of literature—Mathematics, including Arithmetic and Algebra, Geometry, and Astronomy; Phonetics, Philology, Grammar, Law, Philosophy, and Theology.

Cantor, the historian of mathematics, was so much struck with the resemblance between Greek geometry and the *Sulva sūtras* that he, as is natural to the European, concluded that the latter were influenced by the Alex-

(1) "Il est évident que si l'on arrivait un jour à pouvoir reporter jusqu'au delà de l'époque d'Hippocrate, la formation de la doctrine médicale indienne, son originalité serait incontestable, mais, du même coup, celle de la médecine grecque serait fort compromise, puisque, comme je le rappellerai dans un instant, les théories sont à peu près identiques de part et d'autre."

andrian school of Hero (215 B. C.). The *Sulva sūtras*, however, date from about the 8th century B. C., and Dr. Thibaut has shown that the geometrical theorem of the 47th proposition, Bk. I., which tradition ascribes to Pythagoras, was solved by the Hindus at least two centuries earlier,¹ thus confirming the conclusion of v. Schroeder that the Greek philosopher owed his inspiration to India.² Nor must we forget that the most scientific grammar that the world has ever produced, with its alphabet based on thoroughly phonetic principles, was composed in India about the 7th or 8th century B. C.³ As Professor Macdonell remarks :
 “ we Europeans..... 2500
 years later, and in a scientific age, still
 employ an alphabet which is not only inadequate to represent all the sounds of our

(1) Journ. As. Soc. Beng. 1875, p. 227.

(2) In his learned work: “Pythagoras und die Inder.” pp. 44-59.

(3) See Goldstücker : “Pāṇini: his place in Sanskrit Literature”

tained notions similar to those of Haas, d'Alviella and others, but after his intimate acquaintance with the literature of the Hindus he had to change or modify his views. We

among scholarly circles, in the West. It would be perhaps too much to complain that classical scholars, for instance, should have a decided repugnance to admit any actual influence on Greek thought or institutions as having been exercised by the thinkers of the East, however ungrudgingly that privilege is conceded to Egypt. Personally I think that they are quite in the right in maintaining that such an influence is, except in a few instances, at present entirely unproven. But surely there are many points of analogy which are most instructive, and suggestive at least of more than an analogical connection; points that may throw light upon the natural course of the evolution of human conceptions and, in doing so, help to throw light on dark corners of the history of that culture out of which our own has arisen. It is a common saying that it is impossible to know any one language well without at the same time knowing another, and I venture to think that a similar remark holds good of the history of religion or of ethics, or of institutions, or of philosophy."

"I know of men who could not construe a line of Sanskrit, and who speak and write of your ancient literature, religion, and philosophy as if they knew a great deal more than any of your best Srotiyas. How often you must have smiled on reading such books! The idea that anything could come from the East equal to European thought, or even superior, never enters the mind of these writers, and hence their utter inability to understand and appreciate what is really valuable in Oriental literature. There is no problem of philosophy and religion that has not

are here reminded of the essay written by Dugald Stewart "in which he endeavoured to prove that not only Sanskrit literature but also Sanskrit language was a forgery made by the crafty Brahmins on the model of Greek after Alexander's conquest" (Macdonnell).

been a subject of deep and anxious thought among your ancient and modern thinkers. We in the West have done some good work too, and I do not write to depreciate the achievements of the Hellenic and Teutonic mind. But I know that on some of the highest problems of human thought the East has shed more light than the West, and by and by, depend on it, the West will have to acknowledge it. There is a very able article in the last number of the *Edinburgh Review* (Jan. 1881), on Dr Caird's 'Philosophy of Religion.' Dr Caird is a representative man in England, and more familiar than most Englishmen with the solid work of modern German philosophers. And what is the last result at which Dr. Caird arrives and of which even the *Edinburgh Review* approves? Almost literally the same as the doctrine of the Upanishads! Dr. Caird writes: 'It is just in this renunciation of self that I truly gain myself; for whilst in one sense we give up self to live the universal and absolute life of reason, yet that to which we thus surrender ourselves is in reality our truer self.' And again: 'The knowledge and love of God is the giving up of all thoughts and feelings that belong to me as a mere individual self, and the identification of my thoughts and being with that which is above me, yet in me—the universal or absolute self, which is not mine or yours, but in which all intelligent beings

Those who attempt to prove that India owes her civilisation—or at any rate such advance and progress in the arts and sciences which make civilisation worth the name—to Hellenic influence seem to be only one degree removed from a Dugald Stewart.

After all, we are afraid, too much has been made of the resemblance between the Greek and the Hindu theory and practice of medicine. The analogy is more superficial than real, and does not seem to bear a

alike find the realisation and perfection of their nature' (p. 257). I need not tell you or any one who knows the Upanishads how powerfully the same doctrine, the doctrine of the *Ātmā* and *Paramātmā*, was put forth by your old Rishis.

"Many years ago I ventured to show that the five-membered syllogism of the Indian *Nyāya* philosophy is the best form that can be given to the syllogism of inductive logic. But European logicians cannot get over the idea that there is no logic like that of our school-men, and that every deviation from it is a mistake.

"The same conceit runs through almost all that is written on Indi. India may be patronised, some works of Indian poets and philosophers may be called clever and curious, but to recognise in anything the superiority of Indian thought, or the wisdom of Indian native opinion, that is out of the question.

"Bio. Essays:" Letter to K. C. Sen.

close examination. The Hindu system is based upon the three humors of the air, the bile and the phlegm, whilst that of the Greek is founded upon four humors, namely, the blood, the bile, the water and the phlegm—a cardinal point of difference.¹

Next to the Charaka and the Susruta, the Vāgbhata, medical authority, who is held in the highest estimation throughout India, is Vāgbhata, the author of *Astāṅgahri-daya* (*lit.* heart or the kernel of the eight limbs or divisions of the Ayurveda). Indeed, in many parts of the Deccan the very names of Charaka and Susruta were forgotten, and Vāgbhata is looked up to as a *revealed* author, and this is one of the reasons which led Haas to conclude that the former succeeded, and owed their inspiration to, the

(1) Cf. "Il y a dans le corps quatre humeurs : le sang, la bile, l'eau et le phlegme."—Œuvres d'Hippocrate, T. vii. p. 475, ed. Littré, (1851). Again : "Les quatre humeurs, sang, bile, phlegme et eau, j'ai démontré comment et pourquoi toutes s'augmentent dans le corps par les aliments et les boissons."—*Ibid*, p. 557.

latter¹ (see *ante* p. xxxiii).

The treatise of Vāgbhata may be regarded as an epitome of the Charaka and the Susruta with some gleanings from the works of Bhela and Hārita, and contains little or nothing that is original.² In Surgery alone the author introduces certain modifications and additions. Mineral and natural salts chiefly figure in the prescriptions along with vegetable drugs; mercury is incidentally mentioned, but in such a perfunctory manner that it would not be safe to conclude that any compounds thereof are referred to. There are, however, a few metallic preparations recommended in it, which would presuppose an advanced knowledge of chemical processes.

The opening salutation of Ashtāṅga, which is addressed either to Buddha or some

(1) "An die Stelle des seines Vorrangs beraubten Susruta würde ich unbedenklich das Ashtāṅgahridaya setzen"—Hippokrates und die indische Medizin des Mittelalters. Z D M.G., V^o 31, p. 649.

(2) See, however, *ante* p. xxix, foot note.

(3) Preface to Vaidyakaśabdasindhu. p. 6.

Buddhistic emblem, clearly reveals the religious faith of 'its author, there is a tradition current among the learned Pundits of S. India, "that Vágbhaṭa, formerly a Brahmin, was persuaded by a Bauddha priest to adopt his religion, which he embraced in the latter part of his life.'" Internal evidence also fully supports our author's proclivities towards Buddhism,² and he seems to have flourished

(1) Preface to Vaidyakaśābhasya. p. 6.

(2) See the numerous passages quoted by Dr. Kunte in his Introduction to Vágbhaṭa, pp. 14-15.

The remarkable passage we have cited above, in which our author asserts the right every man to think for himself (p. xxix), is quite in keeping with the rationalistic age in which he lived, and he further observes in the same place that a medicine will have its efficacy all the same by whomsoever it is prescribed, be he Brahma himself or any body else. It should be commended to those who are lost in admiration over the "keen edged intellect" of Saṃkara, who does not find a better weapon to fight with his opponents than an appeal to the Vedas and other scriptures, see foot note to p. 195.

वाते पिते श्लेषशतौ च पर्यं

तैलं सर्पिर्माषिकं च क्रमेण ।

एतद् ब्रह्मा भाषते ब्रह्मजो वा

का निर्मले बह्वेदीक्षितशक्तिः ॥

अभिधातवशात् किंवा द्रव्यशक्तिर्विशिष्यते ?

Uttara. XL. 85, 86.

at a time when the religion of Sákyā Muni held its own in India. The Chinese pilgrim I'Tsing speaks of a compiler of the eight divisions of the Ayurveda—possibly this may refer to Vágbhaṭa. ¹

Cordier, following no doubt the authority of 'Vaidyakasabdasindhu,' states that, according to Rājatarāṅginī, Vágbhaṭa lived at the time of King Jayasimha (1196-1218 A. D.); this view is quite untenable, and it is one of the many instances which would go to prove that Kalhana in writing his Chronicles had often to draw largely upon vague traditions, and hence his dates are to be accepted *cum grano salis*.²

(1) "These eight arts formerly existed in eight books, but lately a man epitomised them and made them into one bundle."—I'Tsing : "Records of the Buddhist Religion" by Takakasu, p. 128.

(2) The eminent Sanskrit scholar, the late A. M. Barua, in discussing the age of Kshirasvami discards the authority of *Rājatarāṅginī* and observes:—"I do not see any valid reason for regarding it as a historical authority for all its statements and the more I learn the more my view is confirmed." The name of Vágbhaṭa, however, does not occur in Stein's edition of *Rāj.*, which may be pronounced as the most reliable that has yet appeared.

Csoma de Körös was the first to announce that the Thibetan Tanjur contains among others translations of the Charaka, the Susruta, and Vāgbhaṭa.¹ Georg Huth, who has recently critically examined the contents of the Tanjur, concludes that the most recent date at which it can be placed, is 8th century A. D.² This is in agreement with the fact that the Vāgbhaṭa was one of the medical works translated by order of the Caliphs. But no positive information as regards the most distant date is yet available ;³ Kunte, from internal evidence, is inclined to place him "at least as early as the second century before Christ."

That Hindu Pharmacopœia in the 7th century ran on the lines of the Charaka and the Susruta, and did not include any e a-

Hindu Pharmacopœia in the 7th century.

(1) Journ. Asiatic Soc. xxxvii. (1835).

(2) Zeit. deut. morg. Ges. T. lxix, pp. 279-284.

(3) Regarding the bibliography of Vāgbhaṭa, see two short monographs by Dr. Palmyr Cordier; also Julius Jolly : "Zur Quellenkunde der indischen Medizin," I. 'Vāgbhaṭa, Zeit. deut. Morg. Ges. LIV. pp. 260-74.

borate metallic preparations is evident from the testimonies of Váña and of the Chinese pilgrim, I-Tsing. Thus, we read in the Harsha-Charita : "among their number, however, was a young doctor of Punarvasu's race named Rasáyana, a youth of about eighteen years of age, holding an hereditary position in the royal household, in which he had been cherished like a son by the King. He had mastered Ayurveda in all its eight divisions, and, being naturally of an acute intellect, was perfectly familiar with the diagnosis of diseases :"¹ I-Tsing also records : "I made a successful study in medical science, but as it is not my proper vocation, I have finally given it up."² In his rules on giving medicine he further lays stress on abstinence and fasting and recommends such drugs as the myrobalans, ginger, pepper, liquorice, etc.

(1) Cowell and Thomas' Trans. pp. 143-144.

(2) Takakasu : "Records of the the Buddhist Religion," p, 128.

In both instances, in vain do we look for any metallic salts, which form the leading features of the later Tantric and Iatro-Chemical Schools.¹

(1) See, however, below under the marginal heading :
"The age of the Tantras dealing with mercury."

CHAPTER III

The Transitional Period

Circa 800—1100 A. D.

VRINDA AND CHAKRAPANI

We now come upon a period which determines the parting of ways in the progress of Hindu medicine. Hitherto we have been chiefly concerned with herbs and simples and a few readily available products of the mineral kingdom. About the year 1050 A. D. Chakrapáni Datta, himself a learned commentator of both the Charaka and Susruta, wrote the celebrated medical treatise which bears his name. Since the days of Vagbhata, metallic preparations had begun slowly to creep into use, and at the time of Chakrapáni and his predecessor Vrinda, they had so fully established their claims that they could no longer be ignored. Thus we find from

the tenth century and downward every medical work more or less recommending compounds of metals which can only be synthetically prepared.

It should not, however, be forgotten that Susruta at times shows a knowledge of pharmacy, unsurpassed in the later Hindu medicine.

Although Chakrapāni belonged to the Brahmanical creed, his writings show a decided leaning towards Buddhism. Thus Maghadha itself is named मङ्गबोधिभूदेश or the country of the Mahābodhi ; we have also such expressions as बोधिसत्त्वेनभाषितं, सुखावती वृत्ति, सौगतमञ्जनम् । This might well be expected, for Chakrapāni's father was physician to king Nayapāla, the successor of Mahipāla, who ascended the throne about 1040 A.D.¹

(1) The author, fortunately for future historians, has given an account of himself in a colophon :—

गोदाधिनाथरसव्यधिकारिपात्र-

नारायणस्य सनयः सुनयोऽनिरुद्धात् ।

Both *Vrinda* and *Chakrapáni* mention *Nág-árjuna* as an authority, and they follow closely in the footsteps of *Charaka*, *Susruta* and *Vágbhata* ; but at the same time they are amenable to the influences brought to bear upon medicine by the *Tantras*.

Indeed, they go so far as to recommend the uttering of the cabalistic interjections of the votaries of the Tantric cult with a view to increase the efficacy of some of their preparations.¹ (see *ante* p. i.)

Dr. Hoernle observes : " it would be satisfactory to be able to discover what

भगवान् प्रसिद्धलोध्राली कुलानः

श्रीचक्रपाणिर्ह कर्मपदाधिकारी ॥

"The author of this work is Sri C. P., who belongs to the family of *Lodhrávali* and who is younger brother of *Bhānu* and the son of *Náráyana*, the superintendent of the kitchen of the King of Gour." Regarding the date of *Nayapála*, *vide* Cunningham's "Archaeological Survey of India," III. p. 119, also Journ. As. Soc. LX. Pt. 1. p. 46, *Life of Atisa* by S. C. Dāsa.

(1) अथं मन्त्रः प्रयोक्तव्यो भिषजा चाभिमन्त्रये ॥

श्रीं नमो विनायकाय अमृतं रत्न रत्न मम फलसिद्धिं

देहि देहि बद्धवचनेन स्वाहा । १७ इन्द्रसायनाधिकारः ।

the sources were on which Chakrapáni drew for his compilation ; they are not specified anywhere, I believe, in his work. " ¹ It is not easy to account for the above remarks, seeing that Chakrapáni distinctly mentions that he has modelled his work on the Siddha-yoga of Vrinda, ² and that he draws largely upon the Charaka, the Susruta and the Vágbhata, all of whom he quotes verbatim and at length.

The religion of Sákya-muni inculcates the alleviation of distress and suffering, both moral and physical, as one of the essential articles of faith, and hence we find throughout

“इदमिह दृष्टीपकरणमितदृष्टत्तु मन्त्रेण ।

स्वाहान्तेन विमर्हो भवति फलमेव लोहवत्तरसा ।

सममस्कारेण बलिर्भक्षयमयसो ह मन्त्रेण ॥

“सो” अमृतोद्भाय स्वाहा ।” “सो” अमृते भू फट् ।”

“सो” नमश्चक्रवज्रपाणये महायज्ञसेनाधिपतये सुरगुरुविद्या-

महावलाय स्वाहा ।” “सो” अमृते हूं । इति चक्रपाणि-

रसायनाधिकारः ।

(1) Journ. As. Soc. Beng. LX. pt. 1. p. 150.

(2) यः सिद्धयोगलिखिताधिकसिद्धयोगा-

नमैव लिखिपति केवलमुत्तरेण ।

Buddhistic India hospitals attached to the numerous monasteries for the treatment of man and beast alike. ¹ It would also appear that inscriptions were engraved on rock pillars giving recipes for the treatment of diseases. Thus both *Vrinda* and *Chakrapáni* speak of a formula for a collyrium as inscribed on a stone pillar by *Nágárjuna* at *Pátaliputra* :
 नागार्जुनेन लिखिता स्तम्भे पाटलिपुत्रके ।

Chakrapáni bases his work on that of *Vrinda*, who again follows closely the order and the pathology of the *Nidána* of *Mádhavkara*. ² It necessarily follows that *Vrinda* was a recognised authority at least one or two centuries before the time of *Chakrapáni* and that the former was preceded by the *Nidána* by at least as many centuries and thus we have internal evidence of the exis-

(1) "Everywhere the King Piyadasi, beloved of the Gods, has provided medicines of two sorts, medicines for men and medicines for animals." Edict II. of Asoka.

(2) *Vrinda* himself admits this :

हन्तेन * * * संलिख्यते गदविनिश्चयक्रमेण ॥

tence of the Nidána in the eighth century as the lowermost limit—a date which is further corroborated by the fact that the Nidána was one of the medical treatises translated by order of the Caliphs.

As regards alchemy in India in the XIth century, we cannot do better than quote *in extenso* Albérúní, who was well versed in Arabic and Greek astronomy, chemistry etc.

Alchemy in the
eleventh century.

“ The Hindus do not pay particular attention to alchemy, but no nation is entirely free from it, and one nation has more bias for it than another, which must not be construed as proving intelligence or ignorance ; for we find that many intelligent people are entirely given to alchemy, whilst ignorant people ridicule the art and its adepts. Those intelligent people, though exulting boisterously over their make-believe science, are not to be blamed for occupying themselves with alchemy, for their motive is simply excessive eagerness for acquiring fortune and for avoiding misfortune. Once a sage was asked why scholars always flock to the doors of the rich, whilst the rich are not inclined to call at the doors of scholars. ‘ The scholars,’ he

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answered, 'are well aware of the use of money, but the rich are ignorant of the nobility of science.' On the other hand, ignorant people are not to be praised, although they behave quite quietly, simply because they abstain from alchemy, for their motives are objectionable ones, rather practical result of innate ignorance and stupidity than anything else.

"The adepts in this art try to keep it concealed, and shrink back from intercourse with those who do not belong to them. Therefore, I have not been able to learn from the Hindus which methods they follow in this science and what element they principally use, whether a mineral or an animal or a vegetable one. I only heard them speaking of the process of *sublimation*, of *calcination*, of *analysis*, and of the *waxing of talc*, which they call in their language "tālaka," and so I guess that they incline towards the minerological method of alchemy.

"They have a science similar to alchemy which is quite peculiar to them. They call it *Rasāyana*, a word composed with *rasa* i.e. gold.¹ It means an art which is restricted to certain operations, drugs, and compound medicines, most of which

(1) See, however, p. 79, for the meaning of the term 'rasa'

are taken from plants. Its principles restore the health of those who were ill beyond hope, and give back youth to fading old age, so that people become again what they were in the age near puberty; white hair becomes black again, the keenness of the senses is restored as well as the capacity for juvenile agility, and even for cohabitation, and the life of the people in this world is even extended to a long period. And why not? Have we not already mentioned on the authority of Patañjali that one of the methods leading to liberation is Rasāyana? What man would hear this, being inclined to take it for truth, and not dart off into foolish joy and not honour the master of such a wonderful art by popping the choicest bit of this meal into his mouth?" Sachau's Trans. Vol. I. pp. 187-88.

CHAPTER IV

The Tantric Period

Circa 1100 A.D.—1300 A.D.

Before we proceed further, it would be advisable to take a hasty glance at the origin of the Tantric Cult, as Indian Alchemy very largely derives its colour and flavour from it. In almost every country the progress of chemistry can be traced to medicine and the belief in the artificial gold-making,—the search after *elixir vitæ* and the philosopher's stone. In India, however, these ends have played a secondary part in promoting a knowledge of the chemical processes. Here the origin of astronomy, geometry and anatomy is to be sought in the exigencies of religious rites.¹ No less

(1) Cf. the opening remarks by Dr. Thibaut on the "Sulva-sûtras" :—

is the case with alchemy. We have already seen how the Atharva-veda deals almost exclusively in charms, sorcery, exorcism of diseases by means of amulets and so on. It is sometimes supposed that the A.V. represents the latest of the Vedas. This is evidently a misimpression.¹ The truth seems to be that human frailty has always fought shy of the tedious and laborious methods of gaining an object. The spiritual hankering as foreshadowed in the prayers of the *R̥ik*, and later on so fully developed

“It is well known that not only Indian life with all its social and political institutions has been at all times under the mighty sway of religion, but that we are also led back to religious belief and worship when we try to account for the origin of research in those departments of knowledge which the Indians have cultivated with such remarkable success. At first sight, few traces of this origin may be visible in the *Sāstras* of the later times, but looking closer we may always discern the connecting thread.”—“Journ. As. Soc.” (1875) Vol. XLIV. part 1. p. 227.

(1) As Bloomfield remarks:—There is no proof that even the oldest parts of the *R. V.* or the most ancient Hindu tradition accessible historically, exclude the existence of the class of writings entitled to any of the names given to the Atharvan charms.’ Intro. to A. V. X. pXX.

in the Upanishads, represents only the aspirations of the few cultured *Rishis*. The bulk of the people have always sighed for a royal road to salvation, hence the necessity for an A.V.; as Emerson appositely says in his essay on Demonology, "the history of man is a series of conspiracies to win from Nature some advantage without paying for it." Atharvanic rites have therefore more or less held sway over mankind in every age and clime. As the Aryan conquerors began to settle in India and came into frequent contact with the aborigines, they had unconsciously to imbibe some of the gross superstitions of the latter, and thus in course of time a superstructure of monstrous growth sprang up, ready to swallow even the purer and more orthodox creed. Hence the protests recorded from time to time in the *Mahābhārata* and in the law-books against the vulgarity of the aims of the A. V. and the refusal to accept its authority (see *ante* p. viii). But on the other hand, by virtue of its profound hold

upon popular beliefs and because indisper-
sable sciences like medicine and astrology
are Atharvanic by distiction, the fourth
Veda has always retained a considerable
following.' If we turn to Europe in the
middle ages, we find the professors of the
"black art" sharing a fate similar to the
priests of the Atharvanic rites,——now
openly received into the bosom of the holy
church——now anathematised and flung
into prison. ²

In the Sanskrit Literature whenever there
is any reference to sorcery or magic, it is
generally laid to the account of the A. V.
But in the course of time the worship of
Siva came into vogue, which incorporated
much that was non-Aryan in character, and
which seems to have got blended with A. V.

(1) Bloomfield —Intro. to *A. V.* xlvii.

(2) This is exemplified in Albertus Magnus and Roger Bacon.
The former rose to be a Bishop but "minder glücklich oder un-
vorsichtiger als Albertus Magnus, entging Roger Baco der Verfol-
gung als Zauberer nicht. Er wurde in Oxford von seinen eigenen
Klosterbrüdern in das Gefängniss geworfen." — 'Gesch. d.
Chem.' 1. 63.

rites as modified by changes and requirements of the time. The original inhabitants, "the Dasyus are described in the *Rigveda* as non-sacrificing, unbelieving and impious. They are also doubtless meant by the phallus-worshippers mentioned in two passages. The Aryans in course of time came to adopt this form of cult. There are many passages in the *Mahábhárata* showing that Siva was already venerated under the emblem of the phallus when that epic was composed."

By the VIIth century A. D., we find Siva's worship well established in India. In the life of King Harsa by Vána there is a graphic description of a weird ceremony performed by a Saiva saint named Bhairavácháryya. "Seated on the breast of a corpse which lay supine, anointed with red sandal and arrayed in garlands, clothes and ornaments, all of red, himself with a black turban, black unguents, black amulet, and black garments, he had

Tantric rites
prevalent in the
seventh century.

(1) Macdonell : "Hist. Sansk. Lit". p. 153.

begun a fire-rite in the corpse's mouth, where a flame was burning." ¹ In the drama of *Málatímádhava* by Bhavabhūti (690 A.D.) we have also references to similar rites.

We have here the outlines of what has been known latterly as the Tantric Cult—a curious admixture of alchemical processes on the one hand, and grotesque and obscene and sometimes revolting rites on the other—all centred round the worship of Siva and his consort Párvatí. The sidelight which is thrown in the life of King Harsa and the graphic account left by his contemporary, the Chinese pilgrim Hiuen Thsang, enable us to draw a picture of N. India in the VIIth century A.D. It has hitherto been taken almost for granted that Buddhism was expelled from India by the persecution of the Brahmins of the Renaissance period. There may have been zealous bigots who now and then went the length of hunting down Buddhists ; but the consensus of testimonies seems to be that both the

(1) Cowell and Thomas' "Trans. of the Harsa-charita p. 92."

people and the princes generally maintained an attitude of philosophic toleration towards the creed of Sákya-muni even so late as the XIth century A.D.' The causes which brought about the extinction of Buddhism in

The causes which brought about the extinction

India worked from *within*. The purity of life, and the austerity of practices enjoined on the followers of the creed, become in the long run irksome.

(1) Cf. 'The annual report of the Asiatic Soc. to hand :—

"The copper-plate of Madanapála which has just been referred to is interesting also from a sociological point of view. We know that all the Pála kings were followers of the Buddhist religion, and that it was during their reign that Buddhism flourished for the last time in India. Now the grant recorded in the plate was made by Madanapála to a Brahman as a *dakshina* or honorarium for having read the Mahábhárata to the queens of the king's harem. This is one more fact, in addition to others previously known, showing the intimate connexion that existed in the time of those Buddhist kings between Buddhism and Hinduism, a connexion that resulted in the former losing more and more its ground against the latter, and that thus prepared the way for the final destruction of Buddhism by the Muhammedan invaders." p. 26. Similar evidence is also afforded by Raj. Tar. e.g.

"Kāhāna does not hesitate to refer repeatedly to the Bodhisattvas or to Buddha himself as the comforters of all beings, the embodiments of perfect charity and nobility of feeling. They are to him beings of absolute goodness "who do not feel anger even

The monasteries degenerated into hot beds of corruption, so much so that the semi-savage Mussulman conquerors felt little compunction in putting the inmates thereof to the sword. 'Hinduism also, which has been noted in all ages for its assimilative and elastic character, swallowed up the remnants of the Buddhists by acknowledging the founder of their religion to be an *Āvatāra* or Incarnation of Vishnu.

We have seen that the A.V. rites as also the Tantric cults cover almost identical ground; both had their origin in the attempts at popularising the religion among the masses by appealing to the baser or the less refined elements of human nature. An enormous bulky literature has thus sprung up representing this corrupt and effete outgrowth of

against the sinner, but in patience render him kindness.,—Stein's Intro. p. 8.

(1) According to Waddell, the monks with shaven heads were mistaken for idolatrous Brahmins and massacred wholesale. "Journ. As Soc." LXI. pt. 1. p. 20.

Brahminism.¹ There are however two distinct classes of Tantras—Brahminic and Buddhistic—dealing in magic, alchemy, sorcery, and allied subjects, which will claim our attention here. The causes which favoured the rise and progress of the Hindu Tantras equally contributed to the development of the Buddhistic,² only in the latter, instead of Siva and Párvatí, a Buddha, a Tathágata or an Avalokitesvara is often addressed in the invocation as the source and fountain of all knowledge. We have also a class of Tantras which is an admixture of Buddhistic and Saiva cult. A notable example of which is afforded by the

(1) Tantras grew up in Káśmír also : "Tantric cult which in Káśmír is still closely connected with Saiva worship, seems also to have been well known to Kalhana." Stein's Intro. to Raj. Tar p. 80.

(2) Cf. "Pour des esprits grossiers et ignorants, de tels livres ont certainement plus de valeur que les légendes morales des premiers temps du Buddhisme. Ils promettent des avantages temporels et immédiats ; ils satisfont enfin à ce besoin de superstitions, à cet amour des pratiques dévotes par lequel s'exprime le sentiment religieux en Asie, et auquel ne répondait qu'imparfaitement la simplicité du Buddhisme primitif." Burnouf's

Mahákála Tantra.¹ Rasaratnākara, the authorship of which is ascribed to Nágārjuna, also belongs to this category; this work as well as Rasárnava, a Tantra of the Saiva cult, will claim our special attention, as they embody much valuable information on chemistry.

What is it that made these Tantras the repositories of chemical knowledge? The answer is given in the words of Rasárnava (lit. sea of mercury) itself, which extols the virtues of mercury and its various preparations:—

“As it is used by the best devotees for the highest end, it is called *pārada* (quicksilver).”

“Begotten of my limbs, it is, O goddess, equal to me. It is called *rasa* because it is the exudation of my body.”

“It may be urged that the literal interpretation of these words is incorrect, the liberation in this life being explicable in another manner. This

—“Intro a l'hist. du Bouddhisme Ind.” p. 466. Regarding Buddhist Tantras and their relationship to Saiva Tantras, the reader is referred to Burnouf's admirable exposition (loc. cit). See also Barth's. “Religions of India.” p. 201. 3rd ed.

(1) Intro. Hist. Buddh. Ind., p. 480.

objection is not allowable, liberation being set out in the six systems as subsequent to the death of the body, and upon this there can be no reliance, and consequently no activity to attain to it free from misgivings. This is also laid down in the same treatise.

“Liberation is declared in the six systems to follow the death of the body.”

“Such liberation is not cognised in perception like an amblic myrobalan fruit in hand.”

“Therefore a man should preserve that body by means of mercury and of medicaments.”

A few more typical extracts are given below which will throw further light on the subject :

“The body, some one may say, is seen to be perishable, how can then its permanency be effected? Think not so, it is replied, for though the body, as a complexus of six sheaths or wrappers of the soul, is dissoluble, yet the body as created by Hara and Gaurī under the names of mercury and mica, may be perdurable. Thus it is said in the *Rasahridaya* :—

“Those who without quitting their bodies have attained to new ones through the influence of Hara and Gaurī (mercury and mica), are to be praised as *Rasasiddha* (alchemists). All *mantras* are at their services.”

“ The ascetic, therefore, who aspires to liberation in this life, should first make to himself a glorified body. And inasmuch as mercury is produced by the creative conjunction of Hara and Gaurí, and mica is produced from Gaurí, mercury and mica are severally identified with Hara and Gaurí in the verse :—

“ Mica is thy seed, and mercury is my seed ;

“ The combination of the two, O goddess, is destructive of death and poverty.”

“ There is very little to say about the matter. In the *Rasesvarasiddhānta* many among the gods, the *Daityas*, the *Munis* and mankind, are declared to have attained to liberation in this life by acquiring a divine body through the efficacy of quicksilver.”

“ Certain gods, Mahesa and others ; certain *Daityas*, *Kāvya* (*Sukrāchārya*), and others ; certain sages, *Bālakhilyas* and others ; certain kings, *Somesvara* and others ; *Govinda-Bhāgavat*, *Gōvin-danāyaka*, *Charvatī*, *Kapila*, *Vyāli* and others—these alchemists, having attained to mercurial bodies and therewith identified are liberated though alive.”

“The meaning of this, as unfolded by

Siva to Párvatí, is as follows :—

“The preservation of body, O Supreme goddess! is obtained by mercury and by (the suppression of) breath.¹ Mercury, when swooned, cures diseases and when killed, restores life to the dead. Mercury and air when confined, enable a man, O goddess, to fly about.

“The *swooning state* of mercury is thus described :—

“They say quicksilver to be swooning when it is thus characterised.—

“Of various colours, and free from excessive fluidity or mobility (see p. 74).

“A man should regard that quicksilver as dead, in which the absence of the following properties is noticed.—

“Wetness, thickness, brightness, heaviness, mobility.

“The *fixed* condition is described in another place as follows :—

“The character of fixed quicksilver is that it is:—

(1) Here Cowell and Gough translate पवन simply as “air” We are inclined to think, however, that it is used in the sense of *closing the nostrils*—प्राणादान of Yoga philosophy.

"Continuous, readily fusible, efficacious, pure, heavy, and that it can revert to its own natural state." Cf. p. 247.

"Some one may urge : If the creation of mercury by Hara and Gaurí were proved, it might be allowed that the body could be made permanent; but how can that be proved ? The objection is not allowable, inasmuch as that *can* be proved by eighteen modes of elaboration. "Thus it is stated by authorities .—

"Eighteen modes of elaboration are to be carefully discriminated."

"In the first place, as pure in every process, for perfecting the adepts."

And these methods of elaboration are enumerated thus.—

"Sweating, rubbing, swooning, fixing, dropping, coercion, restraining."

"Kindling, going, falling into globules, pulverising, covering."

"Internal flux, external flux, burning, colouring, and pouring."

"And eating it by parting and piercing it — are the eighteen modes of treating quicksilver."

“These treatments have been described at length by Govinda-Bhāgavat, Sarvajña-rāmaśvara and the other ancient authorities, and are here omitted to avoid prolixity.

“By the science of mercury is to be understood not only a branch of chemistry alone, but it is also to be applied to salvation by means of *dehavedha*. Rasārṇava says.—

“You have, O God, explained the killing of metals. Now tell me that process of *dehavedha* by means of which ærial locomotion is effected. Mercury is equally to be applied to metals and body. First make its experiment on metals and then [having thus gained experience] apply it to the body.”¹

(1) We have in some places adopted Cowell and Gough's trans. of Sarvadarsanasamgraha, but the rendering appears to be faulty in many instances, notably in the above sloka. The original runs as follows :—

न च रसश्चास्त्रं चातुर्वादाद्यैर्निवेति मन्त्रव्यं दिङ्मेषधारां तुक्तेरिव परम-
प्रयोजनत्वात् । तदुक्तं रसायने

खीद्वेषधाराया देव यद्वत्तं परमोद्भूतः ।

तं दिङ्मेषधाराया यत्नं खीद्वेषधारा गतिः ॥

यथा खीद्वेष तथा दिङ्मेष कसंख्यः सूतकः सता ।

Emancipation of a man when alive, as declared in the mercurial system, O subtile Thinker ! is (to be found) in the tenets of other schools though holding different methods of arguments. It is according to all sacred texts to be known by knowledge. None, when not alive, is likely to know the knowable and therefore a man must live (to know the knowable)."

"It is mercury alone that can make the body undecaying and immortal, as it is said :—

"Only this supreme medicament can make the body undecaying and imperishable."

"Why describe the efficacy of this metal ? Its value is proved even by seeing it, and by touching it, as it is said in the *Rasārṇava* :—

"By means of seeing it, touching it, eating it, remembering it, worshipping it and bestowing it

समानं कुर्वते देवि प्रत्ययं दैहबोधयोः ।

युष्मै बोधे परीक्षित पचाद्देहे प्रयोजयेदिति ॥

I. C. Vidyāsagar's Ed. (1858).

Here Cowell and Gough render चातुषादार्थे as "eulogistic of the metal;" and बोधे as "blood." Regarding चातुषादः See p. 191.

npou others, six kinds of highest merits are attained.

"Equal merit accrues from seeing mercury as accrues from seeing all the phallic emblems."

"On earth, those at Kedāra, and all others whatsoever."

"In another place we read :—

"The adoration of the sacred quicksilver is more beatific than the worship of all the phallic emblems at Kāśī and elsewhere."

"Inasmuch as there is attained thereby enjoyment, health, exemption from decay, and immortality."

"The sin of disparaging mercury is also set out :—

"The adept on hearing quicksilver heedlessly disparaged should recall quicksilver to mind."

"He should at once shun the blasphemer, who is by his blasphemy for ever filled with sin." Cf. under R. R. S. p. 78.

The quotations given above are from the "Sarvadarsanasamgraha," or a "Review of the different systems of Hindu Philosophy" by Mādhavāchārya, prime minister to Bukka I. of Vijayanagara, and who was elected in 1331 A. D. head-abbot of the monastery

of Sringeri. Of the sixteen philosophical systems current in the 14th century during the author's lifetime, Rasesvaradarsana or the "Mercurial System," is one. From the fact that *Rasārṇava* is quoted in it as a standard work on this subject it would be safe to conclude that it must have been written at least a century or two earlier, say sometime about the 12th century. In Amarasimha's Lexicon (ca. 1000 A. D.)¹ the following synonyms of *pārada* (mercury) are given, namely, *chapala*, *rasa*, and *suta*; but in the vocabulary of Visvakosha by Mahesvara (1188 A. D.) *haravīja* (lit. semen of Siva) is added thereto. Now in the Tantric literature, of which the philosophy of mercury is the main outcome, quicksilver is regarded as the generative principle, and directions are given for making a mercurial phallus of Siva. We may, therefore, take it that the Tantras which deal in mercurial preparations, had their origin sometime about the

(1) Regarding the date of Amarsimha see also p. 146.

11th to 12th century A. D. It would not be justifiable however to hold that the Tantras did not exist before this time.

Although we have maintained above that the alchemical Tantras had their origin about the 11th century A. D., it would be safer to conclude that the Tantric processes had sprung into existence long before this time, but that they did not acquire sufficient importance to force the attention of the physicians, as we have seen above that the R. V. and the A. V. existed almost side by side though the latter was held for a long time in contempt and was not quoted in the orthodox treatises.

One very strong argument in favour of much older dates of the above Tantras is that Mádhavácharya, a very cautious and discriminating writer, whom we have quoted above, describes the works he cites, including Rasárnava, as "ancient authorities" in his

life-time (see above p. lxxvi)

We have already had occasion to draw attention to the non-mention of metallic preparations, notably of those of mercury, in the writings of Vāna and I'Tsing (p. li). But this is another apt illustration of the dangers of the *argumentum ex silentio*. In the *Vrihatsamhitā* of Varāhamihira (d. 587 A. D.) there is mention of iron and mercury among the aphrodisiacs and tonics; and this his-

Earliest historical evidence of the internal use of mercury.

(1) A recent examination of the Sanskrit Mss. in the Durlar Library of Nepal has brought to light important old Tantric works. One, the *Lamkavatāra*, a Hindu Tantric work on medicine, written in a later Gupta hand 908 A. D.; another, "the composition of which must go back to the early centuries of the Christian era." This discovery upsets all established theories as to the age of the Tantras, a full discussion of which must be reserved for the second volume *Vide*.—Rep. on the Search of Sans. Mss. (1895-1900) by M. H. P. Sisti.

- (2) रत्नसिन्धवे स्त्री प्रकल्पे यत्रो नपुंसकं शीघ्रितयुक्तमाद्ये
यस्मान्न यस्मिन्निदानीं निवेदितवानि रत्नसिन्धवे ॥ १ ॥
सात्रीकथानुसंधारदशोद्धृत्य-
यस्मिन्निदानीं उद्धृतानि योऽद्यात् ।
सैकानि वंशानिरुद्धानि जराश्रितोऽपि
योऽश्लीलिकोऽपि रत्नसिन्धवे बुद्धे ॥ २ ॥

torical evidence is of great use to us in deciding the age of the Tantras, dealing with mercury.

Contemporary collateral records by foreign writers go to corroborate the date of the alchemical Tantras tentatively fixed by us, as the name and fame of mercurial remedies as used by the Hindu *yogis* had spread far and wide. The following two extracts will suffice :

"There is another class of people called *Chughi* (yogi), who were indeed properly Abraiman, but they form a religious order devoted to the idols. They are extremely long-lived, every one of them living to 150 or 200 years. They eat very little
* * * and these people make use of a strange beverage, for they make a potion of sulphur and quicksilver mixed together, and this they drink twice every month. This, they say, gives them long life ; it is a potion they are used to take from their childhood."—Yule's "Macro Polo," Vol. II. p. 300.

"Arghun, der alchymie und den geheimen Wissenschaften ergeben hatte indisehe Bachschi, d. h. Schreiber, gefragt, durch welche Mittel sie

sich ihr Leben so langwierig fristeten. Sie gaben ihm ein aus Schwefel und Merkur zusammengesetztes Mittel als die Panacee der Lebensverlängerung ein." (1290 A. D.)—Hammer-Purgstall; "Geschichte der Ilchane," I. p. 391.

It is to be regretted that of the several works quoted by Mádhava, Alchemical Tantras. Rasárnava alone seems to have survived to our days. This work is almost unknown in Bengal, and extremely rare even in N. India and the Deccan. We have been fortunate enough to procure a transcript of it from the Raghunátha Temple Library, Kásmír, and another from the Oriental Mss. Library, Madras. As one of the earliest works of the kind, which throws a flood of light on the chemical knowledge of the Hindus about the 12th century A. D., Rasárnava must be regarded as a valuable national legacy. It has, besides, the merit of being the inspirer of several works of the Iatro-chemical period, notably Rasaratna-samuchchaya and Rasendrachintámazí. Although Rasárnava as a Tantra pretends to

have been revealed by the God Siva himself, its author, whoever he may be, now and then blurts out hints, which clearly prove it to have been compiled from preëxisting works, for instance, it has not hesitated, as we find ; to borrow copiously from Rasaratnākara attributed to the renowned alchemist Nāgārjuna. Of this last work we have been able to obtain as yet only a fragment from the Kāśmīr Library ; but it has been of signal use to us, as by the parallelism of its text the genuineness and authenticity of a great portion of the Rasārṇava have been established.

In the present volume it has been our aim to compare and collate carefully the passages in the Mss. of Rasaratnākara, Rasārṇava and Rasatnasamuchchaya, in so far as they bear on chemistry and allied subjects ; in this way several important lacunæ have been filled up and many doubtful readings restored. Parallel passages have often been quoted in the foot-notes and cross-

Collation of Mss.

references given, pointing out where the probable borrowing has taken place. It is to be hoped that by instituting this sort of intercomparison, the verbal integrity of the texts adopted may be depended upon, and the danger of interpolation has been avoided. The texts of Charaka, Susruta, Vágbhata and Chakrapāṇi have not been reproduced as they are available everywhere in the most reliable shape.

The translations presented do not always pretend to be strictly literal, and we hope the indulgent reader will put up with infelicities of expression here and there, which could not be avoided without taking undue liberty with the original. We have drawn very largely upon R. R. S., because it has several features to recommend. First, an excellent edition of it has been published at Puna, based upon a comparison of 13 Mss., procured from different parts of Southern India. Second, there exists a Ms. of it in the library of the Sanskrit College, Benares, in a very neat and

Recommendatory
features of R. R. S.

legible handwriting, copied in samvat 1850 i. e. 1793 A.D., to which we have had access whenever required. We have also obtained a transcript of it from the Kásmír Library. The Benares and the Kásmír Mss. agree in all essentials, but differ in certain places from the Puna edition. The text we have adopted is thus based upon a comparison of the Deccanese and N. Indian exemplars. Third, while Rasaratnákara and Rasárñava are Tantras pure and simple in which alchemy is incidentally dwelt upon, R. R. S. is a systematic and comprehensive treatise on materia medica, pharmacy and medicine. Its methodical and scientific arrangement of the subject-matter would do credit to any modern work, and altogether it should be pronounced a production unique of its kind in Sanskrit literature. Its value is further enhanced from the fact that the materia medica portion is harmoniously blended with chemistry.

The author, whoever he may be, is very
 pseudo-Vágbhaṭa. anxious to establish his
 identity with V á g b h a ṭ a ,

the celebrated author of the *Ash/aṅga* and describes himself as such in the colophons at the end of every chapter (p. 78); but he forgets that in doing so he is guilty of a glaring piece of anachronism. The chemical knowledge, as revealed in the *Vāgbhaṭa*, is almost on a par with that in the *Susruta*. But this sort of utter disregard for chronological accuracy is by no means uncommon in the alchemical literature of the middle ages in Europe. The world is indebted to the genius and perseverance of M. Berthelot for unravelling the mysteries which so long hung about the writings of Geber¹; and the interval of time between our pseudo-*Vāgbhaṭa* and the author of *Ash/aṅga* is even much wider than that between the Latin Geber and the real Geber. We are apt to be very harsh

1) "L'hypothèse la plus vraisemblable à mes yeux, c'est qu'un auteur latin, resté inconnu, a écrit ce livre dans la seconde moitié du XIII^e siècle, et l'a mis sous le patronage du nom vénéré de Gêber; de même que les alchimistes gréco-égyptiens avaient emprunté le grand nom de Démocrite pour en couvrir leurs élucubrations."—"La Chimie au Moyen Âge, T. 1. p. 349.

on these literary forgers ; rather we ought to give them credit for their utter self-effacement. We often forget that the spirit of the times in which they wrote was dead against them—reluctant to accept revolutionary ideas or discoveries ; hence the temptation to fasten them on old and recognised authorities.

Although no direct historical evidence is available, we are not left entirely in the dark. Our author, at the very outset, names twenty seven alchemists from whose writings he derives his materials (p.77), and later on, in the section on apparatus (p. 130), he quotes Rasárnava as a source of his information. Opium was not employed in medicine in his time nor is there any mention of Phiraṅgaroga, (lit. the disease of the Portuguese),¹ which was introduced into India about the middle of the 16th century, and the treatment of which by means of calomel and *chob-chini*

Probable date of
R. R. S.

(1) This is the name by which syphilis is known in the later Hindu medical works. See p. 252.

(China root) occupies a conspicuous place in in the much later work, Bhāvaprakāśa. The date of the R. R. S. may, therefore, be placed between the 13th and 14th centuries A. D.

CHAPTER V

Iatro-Chemical Period

During the Tantric period, with its system of the "Philosophy of Mercury" a vast mass of chemical information was accumulated, which was pressed into signal service in the period immediately succeeding it—the Iatro-chemical Period of India. The prominent feature of the former lies in the search after the *elixir vitae* and the powder of projection as the contents of the *Rasaratnākara* and *Rasārnava* amply testify; whereas in the latter these phantastic and extravagant ideas, impossible of realisation, had subsided into something more practical and tangible. The numerous preparations of mercury, iron, copper and other metals, although they could not secure immortality or revive the dead, were found to be helpful accessories in medicine. At first they came

Characteristics of
the intro-chemical
period.

to be used 'cautiously and tentatively, mixed up with the recipes of the Charaka and the Susruta, which are drawn chiefly from the vegetable kingdom; but they soon began to assert a supremacy of their own and even to supplant the old Ayurvedic treatment by herbs and simples. Nay more, absurd pretensions were set up on behalf of these metallic preparations. Thus in Rasendrachintā-maṇi, a work probably co-eval with R. R. S., we come across this remarkable passage:—
 "Revered teacher! be pleased to instruct me, for the benefit of the weak and the timid, in a mode of treatment which will dispense with the use of the lancet, and both active and potential cauteries," thus putting in a plea for the indiscriminate use of mercurial remedies.

R. R. S. is a typical production of the iatro-chemical period. The name of treatises treating of medicinal chemistry is simply legion. But they are all cast in the same mould, and the close similarity of their contents would render their translation only a

works of supererogation. We have, therefore, confined ourselves to quoting only such parallel passages in the foot-notes as are calculated to throw light upon or corroborate the authenticity of, the text of R. R. S.

An account of this period will be scarcely complete, which fails to take
 Nágárjuna. note of the conspicuous figure whom the Indian alchemists unanimously look upon as the inventor of the processes of distillation and calcination—the renowned and the venerable Nágárjuna, the reputed author of *Kakshaputatantra*, *Rasaratnákara* and *Arogyamañjarí*, etc. Our R. R. S., in the opening lines, invokes him as one of the 27 alchemists, and in the chapter on minerals quotes him as an authority. So does *Rasendrachintámāni* as also *Chakrapāṇi* while describing the process of roasting iron (p. 62).

We have already seen that according to *Vrinda* and C. p., Nágárjuna was the first to introduce the preparation known as *Kajjvali* (black sulphide of mercury p. 61). *Dalvaṇa* also makes him the redactor of the *Susruta*.

The mention of Nágárjuna by all these authorities would not remove him far from the 8th or the 9th century A. D., a date which is also confirmed by Albérúni, who says :

“ A famous representative of this art [alchemy] was Nágárjuna, a native of the fort Daihak, near Somnáth. He excelled in it and composed a book which contains the substance of the whole literature on this subject and is very rare. He lived nearly a hundred years before our time.’ — ‘India, 1. p. 189.

But there are difficulties in the way of accepting this chronology of the age of Nágárjuna. Hiouen Thsang, who resided in India from 629 A. D. onwards, relying upon local traditions, speaks of Nágárjuna.¹ as a

(1) “ Nágáruno Bodhisatva was well practised in the art of compounding medicines, by taking a preparation (pill or cake) he nourished the years of life for many hundreds of years, so that neither the mind nor appearance decayed. Satváha-rāja had partaken of this mysterious medicine.” — Beal’s Buddhist Records of the Western World, vol. II, p. 212

Again “ Nágárjuna Bodhisatva, by moistening all the great stones with a divine and superior decoction (medicine or mixture) changed them into gold.” — *Ibid.* p. 216.

learned and revered Buddhist and alchemist, and a friend of King Satvāhana. ² The poet Vāṇa, a contemporary of the Chinese pilgrim, also corroborates this account in his life of King Harsha

In the Buddhist canonical literature, Nāgārjuna is a prominent figure as the founder, or, at any rate, the systematiser of the Mādhyamika philosophy. Western scholars maintain that he lived in the 1st century A.D., while according to Rājatarāṅginī, the "History of Kasmīr" by Kalhaṇa Misra (11 century A. D.), Nāgārjuna flourished 150 years after Sakyasiṃha had betaken himself to asceticism, *i.e.* he lived in the last quarter of the 4th and first quarter of the 3rd century B. C. It is doubtful, however, if Nāgārjuna, the philosopher, is the same as Nāgārjuna, the alchemist, considering

(2) Nāgārjuna was a friend of Satvāhana, a king of Kosala country to the South West of Urisya and watered by the upper feeders of the Mahānadi."—*Ibid.* II. p. 209. As to the age of Satvāhana see Burgess' Archaeological Survey of S India. Regarding Nāgārjuna see also Introd. à l'histoire du Buddh. Ind. p. 508.

that we find no reference whatever to the processes of distillation, sublimation etc. in the Charaka, the Susruta, and the Vāgbhaṭa, though it must be admitted that the latter can lay claim to superior chemical knowledge. (see p. xlvi).

We have also another alchemist in Patañjali, who is better known as Patañjali, the commentator of Pāṇini. He probably lived in the 2nd century B. C.¹ Sivadása, in his commentary of Chakrapāṇi, quotes him as an authority on Lohasāstra, or the "Science of Iron," and Chakrapāṇi himself speaks of him as the redactor of Charaka (see p. xv). Bhoja in his Nyāyavārtika speaks of Patañjali, as a physician both to the mind and to the body.² The moksha (salvation), as taught in the Yoga system of Pātañjali, is

(1) Proof Bhandarkar Ind. Antiquary. 1872, pp 299-302.

(2) "योगेन चित्तस्य पदेन वाचां मर्त्यं शरीरस्य तु वैद्यकेन ।
योऽपाकरोत् तं प्रवरं मुनीनां पतञ्जलिं प्राञ्जलिरानताऽस्मि ॥"

—Bhoja . Nyāyavārtika, quoted by Sivaráma, the commentator of Vāsavadatta.

also connected with alchemy. ' We have already seen, while discussing the "Philosophy of Mercury" (see *ante* p. lxxvi), the Rasáyana or Alchemy was simply regarded as a means to an end—as a path leading to moksha. It is significant that this connection can be traced from so early a date.

In the present volume we shall seldom have occasion to go beyond the 14th century A. D. It will, perhaps, add to the interest of the subject, if we turn our eyes for a moment to the progress of chemical knowledge in Europe at that time, and the alchemistic ideas and beliefs dominating it. Contemporary with the authors of Rasārṇava and Rasartnasamuchchaya, were Roger Bacon (d. 1294), Albertus Magus, Raymond Lully, and Arnaldus Villanovanus. Roger Bacon does not hesitate to assert that the philoso-

(3) The author (Patañjali) adds to the three parts of the path of liberation a fourth one of an illusory nature, called Rasáyana, consisting of alchemistic tricks with various drugs, intended to realise things which by nature are impossible."—Albérúni's 'India'—I. p. 80

pher's stone was able to transform a million times its weight of base metal into gold. The above-named alchemists are also unanimous in regarding it as a universal medicine, and "it was no unusual assertion that adepts, the fortunate possessors of the panacea, had been able to prolong their lives to 400 years and more."—Meyer. The readers of *Rasárnava* and the other Tantras will not fail to find that there is much in common between the Hindu alchemists and their European *confrères*.

The knowledge in practical chemistry, prevalent in India in the 12th and 13th centuries A. D., and perhaps earlier, such as we are enabled to glean from *Rasárnava* and similar works, is distinctly in advance of that of the same period in Europe. It was known for instance that blue vitriol and a variety of the pyrites (see p. 70) yielded an essence in the shape of copper; and calamine, zinc. The colour of flames as a

Knowledge in practical chemistry, prevalent in India in the 12th and 13th centuries A. D., and perhaps in earlier.

diagnostic test of metals was well understood (p. 68). The metallurgical processes, described under the latter, leave little to improve upon (p. 88), and, indeed, they may be transferred bodily to any treatise on modern chemistry. Even Paracelsus, who flourished some three centuries later, leaves us in the dark as to the nature of his 'zinken,' which he designates a 'semi' or 'bastard' metal. And Libavius (d. 1616) "who stood up manfully against the excesses of Paracelsus, and who vigorously combated the defects in his doctrines, * * * and the employment of "secret remedies," believed in the transmutation of the metals and the efficacy of potable gold.¹ It is not necessary to pursue this subject further here, as details will be found in the chapter on metallurgy (pp. 152-169).

The truth is that up till the time of pseudo-Basil Valentine (ca. 1600 A. D.),

(1) Gesch. d. chem. I. 13.

very little scientific progress was achieved in Europe. The doctrines of Aristotle and of the Arabian alchemists held the ground, and the enigmatic and mystic language, which was often used as a cloak for ignorance, simply confounded the confusion.

Still more solid progress was effected in pharmacy. For two thousand years or more the Charaka and the Susruta have been paid all the honours of a state-recognised Pharmacopœia. Partly due to their being regarded as of revealed origin, and partly due to that veneration for the past, which is inherent in the Hindu, the text of the above works has seldom been allowed to be tampered with. A critical examination of the Bower Ms. such as we owe to Dr. Hoernle, shows that the recipes of several important preparations agree in all essentials, and sometimes word for word, with those of the Charaka and the Susruta of the existing recensions (see *ante* p. xix). Mr. Ameer Ali is scarcely correct when he claims that "the Arabs invented chemical pharmacy, and were the founders of

those institutions which are now called dispensaries.'¹

We have only to refer our reader to the chapter on the preparation of caustic alkali, in the Susruta, with the direction that the strong lye is to be "preserved in an iron vessel," as a proof of the high degree of perfection in scientific pharmacy achieved by the Hindus at an early age (p. 37). It is absolutely free from any trace of quackery or charlatanism, and is a decided improvement upon the process described² by a Greek writer of the IXth century, as unearthed by M. Berthelot.² As regards *dispensaries* and hospitals, every one knows that Budhistic India was studded with them (*vide* p. xxxii).

Speaking of the progress of chemistry in Europe in the XVIth century, Prof. Schorlemmer remarks :—

"Up to the XVIth century almost the sole object of chemical research had been to find the

(1) Hist. of the Saracens, p. 462, (Ed. 1899.)

(2) See p. 22.

philosopher's stone. But now chemistry began to develop itself two new and different paths, opened by two distinguished men—Agricola, the father of metallurgy, and Paracelsus, the founder of Iatro-chemistry or medical chemistry. Both contributed chiefly to the development of inorganic chemistry * * * In opposition to the school of Galen and Auicenna, Paracelsus and his followers chiefly employed metallic preparations as medicines.”¹

Udoy Chand Dutt, in the preface to his *Materia Medica of the Hindus*, states :—

“The oldest work, containing a detailed account of the calcination or preparation of the different metals (such as gold, silver, iron, mercury, copper, tin and lead) for internal use with formulæ for their administration, is, I believe, a concise treatise on medicinal preparations by Sārṅgadhara.

This is evidently a mistake. Sārṅgadhara is simply a compilation based upon the Charaka and the Susruta on the one hand, and the Tāntric works described above on the other. It cannot be regarded as going beyond the latter part of the 14th century, and

(1) Rise and development of Organic chemistry (ed. 1894)

it will come under our notice in the second volume of the present work. In the European histories of chemistry, the credit of being the first to press chemical knowledge into the service of medicine and introduce the use of the internal administration of mercurial preparations, is given to Paracelsus (1493-1541). The Nágárjuna and the Patanjali of India, however, had the merit of anticipating Paracelsus and his followers by several centuries. The earliest historical record of the internal use of black sulphide of mercury, dates so far back as the 10th century A. D. at the latest¹ (see *ante* p. 59). We have indeed, reasons to suspect that Paracelsus got his ideas from the East, and in Chapter on *Arabian indebtedness to India* we have pointed out the media through which Indian sciences filtered into Europe.

(1) In Europe, its use dates from the 17th century. "Das schwarze Schwefelquicksilver lehrte zuerst Furquet de Mayerne im Anfange des 17. Jahrhunderts, durch Zussammenreiben von warmen Quicksilver mit geschmolzenem Schwefel darstellt," Kopp. Gesch. 186,

Dutt says : " We cannot help admiring the ingenuity and the boldness of the Hindu physicians, when we find that they were freely and properly using such powerful drugs as arsenic, mercury, iron, etc., when the Mussulman Hakims around them with imperial patronage and the boasted learning of the West, recording such remarks regarding them as the following :—

‘ Soombookhar, ‘ the white oxide of arsenic.—’ There are six kinds of this, one name Sunkia, the third Godanta, the fourth Darma, the fifth Huldea. The Yunāni physicians do not allow this to form a part of their prescriptions, as they believe it destroys the vital principle. The physicians of India, on the contrary, find these drugs more effectual in many disorders than others of less power such as the calx of metals. For this reason too I am in the habit of seldom giving these remedies internally, but I usually confine my use of them to external application and as aphrodisiacs which I prescribe to a few friends, who may have derived no benefit from Yunāni prescriptions. It is better to use as few of them as possible.”¹

‘ Pārā, ‘ Mercury.’—It is very generally used throughout India in many ways, both in its native

(1) Taleef Shareef trans. George Playfair, p. 99,

and prepared state, but in the latter we ought to be very cautious, for it is seldom sufficiently killed or removed from its native state, in which it is a dangerous drug.”¹

“Loha, ‘iron.’—It is commonly used by physicians in India, but my advice is to have as little to do with it as possible.”²

Nor must we forget that so late as 1566 A. D. the Parliament and the Faculty of medicine, Paris, condemned and forbade what was regarded as the dangerous innovations of Paracelsus.³

Apart from the historical data already adduced, the above extracts from a Mohammedan writer would show that the Hindus were perhaps the earliest in the field to advocate the internal use of mercury.¹ Ainslie, in a note appended “*Lepra Arabum*,” written in the early part of the last century, thus expresses his views on the subject :—

(1) *Ibid*, page 26.

(2) Taleef Shareef, page 146.

(3) *Gesch. d. Chem.* I, 110.

note appended to "Lepra Arabum," written in the early part of the last century thus expresses his views on the subject :—

"It is well known that the Eastern nations were the first who employed mercury in the cure of obstinate, cutaneous and leprous affections; and it may be questioned whether the natives of India were before the Arabian or only second in order in availing themselves of the virtues of that powerful mineral. Rhases, ¹ Mesu and Avicenna ² all notice it, and according to Fallopius, as we find observed by Le Clerc in his "Histoire de la Médecine" pp. 771-791, it was the opinions of those writers which first suggested its use in venereal diseases. ³

(1) "Argentum vivum cum extinguitur ardens est, quod scabei, et pediculis auxilium offert"—Rhazes "de Re med." (lib iii cap. xxiv). In the days of Pliny the Elder the medicinal virtues of mercury do not appear to have been at all ascertained; that writer termed quicksilver the bane and poison of all things and what would with more propriety be called *death* silver. "Nat Hist." lib xxxiii. Cap. vi).

(2) Avicenna says of mercury "argentum vivum extinctum adversus pediculos et lendes cum rosaseo oleo valet" *Vide*
"lib. ii. tract. ii. p. 119.

(3) Trans. R. As. Soc. (1824-27).

From the evidences we have adduced all along there can now be scarcely any question as regards the priority of the Hindus in making mercurial remedies a speciality; and they are entitled to claim originality in respect of the internal administration of metals generally seeing that the Charaka and the Susruta, not to speak of the later Tantras, are eloquent over their virtues.

CHAPTER VI.

Indebtedness of the Arabians to India.

The Arabians are acknowledged on all hands to have played a prominent part in the propagation of science and mathematics in the West. When in the dark and middle ages, the lamp of knowledge had begun to burn very low in Europe and even when the very vestiges of Greek culture and learning had all but disappeared, save in the obscure and dingy cells of the monk, it was the Arabs who carried there the accumulated intellectual treasures of the East, and thus laid the foundation, so to speak, of modern European greatness.

It will, perhaps, be not out of place to discuss here briefly as to how much India indirectly contributed to this result in the departments of medicine, pharmacy and other kindred subjects.

The author of *Kitāb-al-Fihrist*, who wrote towards the middle of the tenth century', Haji Khalifa and Ibn Abú Usaibiah, who flourished at the commencement of the 13th century, distinctly mention that by order of the Caliphs Harun and Mansur several standard Hindu works on medicine, materia medica and therapeutics were translated into Arabic. The information on the subject has been gathered at length by Dietz in his *Analecta medica*, Wustenfeld, author of *Geschichte der Arab. Aerzte*, Cureton², Flügel, Müller and other Arabic scholars.

(1) ... "Abu'l Faraj Mohammed bin Ishak, surnamed au-Nadim, a native of Bagdad, first conceived the idea of a bibliographical dictionary. His *Kitāb-al-Fihrist* deals with every branch of learning. It gives the names of many authors and their works which have ceased to exist."—*Hist. of the Saracens* by Ameer Ali, p. 469.)

(2) Prof. H. H. Wilson in a *Note* appended to a paper by the Rev. W. Cureton entitled "A collection of such passages relative to India as may occur in Arabic writers" thus pithily summarises his own views :—"In medicine the evidence is more positive, and it is clear that the *Charaka*, the *Susruta*, the treatise called *Nidāna* on diagnosis, and others on poisons, diseases of women and therapeutics, all familiar to Hindu Science, were translated and studied by the Arabs in the days of

Flügel¹ states on the authority of *Kitāb-al-Fihrist* that *Susrud* (the Sanskrit name Susruta, thus corrupted into Arabic) was translated by Mankh, the Indian, who cured Harun ar-Raschid of a severe illness, and was appointed physician in charge of the Royal Hospital. We also learn that a work on the official plants of India was rendered into Arabic by the same Mankh. The other comprehensive Sanskrit treatise, the Charaka was also fully laid under contribution.

We have ample and overwhelming testimony of Arabic writers, notably of Haji Khalifa, that Hindu astronomy, algebra and medicine were zealously studied by their compatriots, and many Hindu servants were induced to reside at the Court of the Caliphs as their instructors. Mussulman students,

Harun and Mausur, either from the originals or translations, made at a still earlier period, into the language of Persia."—*Journ. Royal Asiatic Soc.* old series, vi. pp. 105-115.

(1) "Zur Frage über die ältesten Uebersetzungen indischer und persischer medicinischer Werke ins Arabische: Ziet. deut. morg. Ges. xi. pp 148 and 325.

in their eager thirst for knowledge, used to flock to the centres of learning in India, and there drank deep at the very fountain-head. Indeed, it had come to be regarded as an essential part of completing one's liberal education to travel to India and learn the sciences firsthand.

That this is no language of rhetoric will be evident from the extracts quoted below from Gildemeister's "*Scriptorum Arabum De Rebus Indicis loci et opuscula.*"

"Etiam Muhammed ben Ismaïl al Tanûkhi in Indiam profectus est eo imprimis consilio, ut Indorum astronomiam cognosceret.

"Ibn Albaithâr, rei herbariæ inter Arabes peritissimus, qui and eius disciplinae studium longinquâ itinera per Hispaniam Africam et Asiam instituit, etiam in Indiam venit, teste Leone Africano; Abulfadâ tamen et Ibn Abi Ucaibia, qui de eius vita scripserunt, eius rei mentionem non faciunt." p. 80.

"Sed etiam accuratius edocti erant, et scite iam vetus Indopleusta eas disciplinas, in quibus Indi maxime excellerent, nominat has: medicinam, philosophiam et astronomiam. Eodem modo Hagi

Khalfa arithmetica, geometriam, medicinam, astronomiam, et metaphysicam enumerat." p. 81.

"De libris ex Indica lingua in Arabicam conversis iam inter Arabes egerunt ii, qui libros de re literaria composuere. Plurimi de iis sine dubio apud Hag'i Khalfam legentur, cuius hucusque pars tantum publico usui patet. De antiquioribus his libris locuples testis est antiquissimus de Arabum literis scriptor Ibn Abi Yaqub ibn Alnadim, qui in *Indice scientiarum* * * * * * quem scripsit anno 337 (inc. 10 Jul. 948) inter monumenta literarum Arabicarum etiam peculiari cura egit de libris e linguis Graeca, Persica et Indica conversis." p. 82.

Haas, whose criticism of the Susruta we have already noticed, having Müller's refutation of Haas. once taken up the position of denying the antiquity of Hindu medicine with special regard to the Charaka and the Susruta, was driven to the necessity of discounting, nay, explaining away, the numerous references to Hindu works made by Mussulman writers. This had the effect of eliciting a reply from Müller, who subjected the Arabic literature bearing on the subject to a

crucial examination, especially Book XII of Useibia. He finds that not only the Charaka and the Susruta, but also the Nidána and the compendium Asánkar,¹ a book on Poison by Sánáq the Indian, and another on Warm and Cold, and several other works were rendered into Arabic. This German orientalist also arrives at the conclusion that Indian physicians practised at the Court of Bagdad.²

We have now to place before the reader the evidence of a remarkable author —remarkable alike for the depth of his learning, versatility of his genius, rare impartiality of his judgment and his singular freedom from race-bias.

Albérúní lived in India from 1017-1030 A. D., and during this long sojourn he mastered Sanskrit and studied Hindu mathema-

(1) A Variant has "Astankar," which will be readily identified as the Astánga of Vígghaṭa (see p. xlvii.)

(2) "Schon vor Er-Rasid, vielleicht sogar gleichzeitig mit dem Uebergange indischer Astronomie nach Bagdad.....haben sich auch indische Aerzte in Bagdad eingefunden." (Loc. cit. p. 499). "Arabische Quellen zur Geschichte der indischen Medizin." — "Zeit, deut, morg. Ges. 34, p. 465."

tics and philosophy in the original. At a time when his patron, Sultan Mahmud of Ghzni, was busy pillaging the temples in Thaneshwar, Mathura, Kanauj and Somnath with the zeal of an iconoclast, this philosophic Moslem was pondering over the Sámkhya and the Pátañjala, and instituting a comparison between their contents and those of the "Timæus" and its commentator, Proclus.

We have elsewhere quoted at length Albérúni's views on Rasáyana (alchemy); it now remains for us to glean such information from him as will throw light on the subject under inquiry. According to Sachau, the learned translator of Albérúni, "some of the books that had been translated under the first Abbaside Caliphs were extant in the library of Albérúni, when he wrote his India, the Brahmasiddhánta or Sindhind.....the Charaka in the edition of Ali Ibn Zain and the Pañch-tantra or Kalila and Dimna." The fact that the Charaka occupied a place in the library of a cultured Arab affords an additional proof of the esteem in which the Hindu system of

medicine was held by the Moslem world. We also learn that "the Christian philosopher and physician from Bagdad, Abulkahir Alkhamnour, friend of Albérúni, seems to have practised in Ghazni his medical profession" (Sachau). This is significant as indicating that both the Greek and Hindu systems held sway side by side; but more of it anon.¹

So far as regards historical evidence. Let us now see if any internal evidence could be gathered in corroboration of the former. Reference has already been made to the Book on Poisons by Sâñâq the Indian. We shall cite here some parallel passages on the Examination of Poisoned Food and Drink. These are the chief characteristics as given by Sâñâq, the Charaka and the Susruta respectively.

(1) "Dietz also in his *Analecta Medica* proves that the later Greek physicians were acquainted with the medical works of the Hindus, and availed themselves of their medicaments; but he more particularly shows that the Arabians were familiar with them, and extolled the healing art, as practised by the Indians, quite as much as that in use among the Greeks."—Royle: "*Antiq. Hind. Med.*" p. 64.

SANAQ THE INDIAN

THE CHARAKA

THE SUSRUTA

The vapor emitted by poisoned food has the colour of the throat of the peacock when the food is thrown into fire, it rises high in the air; the fire makes a crackling sound as when salt deflagrates the smoke has the smell of a burnt corpse. Poisoned drinks: butter milk and thin milk have a light blue to yellow line.

The food is to be thrown into fire for testing . . . the flame becomes parti-coloured like the plume of a peacock. The tongue of the flame also becomes pointed; a crackling sound is emitted and the smell of a putrid corpse is perceived. . . . Water, milk and other drinking liquids, when mixed with poison, have blue lines printed upon.— "Chikitsá," Ch. xxiii, 29-30.

When poisoned food is thrown into fire, it makes crackling sound and the flame issuing therefrom is tinted like the throat of the peacock.— "Kalpa," Ch. i, 27.

The physician, as superintendent of the kitchen, well-versed in toxicology, is essentially an Indian institution. Cf. Susruta, Kalpa, Ch. I. 6-9

Müller has pointed out the parallelism as shown above. We have, however, added to it the diagnostic test of poisoned food as

given in the Charaka, and it will be seen that Sâṇâq was equally indebted to this authority and to the Susruta.

The description of leeches as given by Rases agrees almost word for word with that of the Susruta (Sanasrad) in many places.

SUSRUTA

The variety of leeches called *Krishnā* is black in colour and have *thick heads*, *Karvurās* have their bodies, like that of eels with elevated stripes across their abdomen. *Alagardhās* have hairs on their bodies, large sides and black mouths, *Indrāyudhās* have longitudinal lines along their back, of the colour of the rainbow.

Sāṃudrikās are of a dark-yellow colour and have variegated spots on their bodies resembling flowers in appearance. *Gochondanās* have bifurcated tails like the two horns of a cow and small heads. When these poison-

RASES, QUOTING SANASRAD

Of the leeches one is poisonous, which is intensely black like antimony having a large head: and scales like certain fishes and having the middle green: also another upon which are hairs, has a large head and different colour like the rain-bow.

ous leeches bite any person, the bitten parts become swollen and very itchy, and fainting, fever, burning of the body, vomiting, mental derangement and langour occur. In these cases the medicine called *Mahāgada* should be administered internally, applied externally and used as snuff. The bite of the leech called *Indrāyudha* is fatal. Such is the description of the poisonous leeches, and their treatment.

Now the non-poisonous leeches. Their names are as follows: *Kapilā*, *Pingalā*, *Sankumukhī*, *Mūshikā*, *Pundarikamukhī* and *Sāvarikā*

in the colour of which there are lines as in blue-spar, bluestone, azure—which often bites: thence will be caused abscess with fainting; with coma and relaxing of the joints: nevertheless of these very leeches there is a good one which is assimilated to the colour of water:

Kapilā have their sides of the colour of orpiment

in which there will be greenness having upon it two lines like arsenic [orpiment] but light red,

and
their back smooth and of the colour of the pulse called

mudga (Phaseolus mungo).

Engalas have round bodies, move quickly, and are of slightly red or tawny colour. *Sāṅkuhmukhīs* are liver-coloured, suck blood quickly, and have large sharp mouths.

day

coloured and corresponding to the colours of liver: which are swift to draw to themselves fine blood:

Mushikas have the colour and shape of rats and a bad smell.

which are assimilated to the tail [colour] of a mouse: having a horrible smell * * *

Pundarikās have mouths like the lotus and are of the colour of the pulse of *Phaseolus mungo*. *Sāvarikās* have green colour like the leaf of the lotus, are functuous, and eighteen fingers in length. They are used only for extracting blood from beasts. Such is the description of the non-poisonous leeches. The non-poisonous leeches are found in Turkey, *Pāṇḍya* (the country to the south), *Sahya* (a mountain on the banks of the *Narbada*)

And having the belly red along with blackness

and *Pautana* (the tract of country about Mathuro). Of non-poisonous leeches, those which are stronger and have large bodies, can drink blood rapidly and eat much, are especially free from poison.

and the back green : they are

Leeches which are produced in dirty water and from the decomposition of poisonous fishes, insects, frogs, urine and fæces are poisonous. *Those produced in pure water and from the decomposition of the different varieties of the Nelumbium Speciosum and the Nymphaea lotus and of Saivāla (Blyxa octandra) are non-poisonous.*

bitter but they will be worse in bad water quite stagnant in which are many small tadpole frogs : *nevertheless, they are good in good and excellent water,*

The varieties of *Nymphaea* mentioned here are *padma*, *utpala*, *kumuda*, *nalina*, *kuvalaya*, *saugandhika* and *pundarka*.

On this subject there is the following verse :—Non-poisonous leeches go about in the field and fragrant water. They do not live in confined

places or lie in mud as they seek comfort. These should be caught by means of wet-leather or some other article. They should be kept in a new large earthen pot filled with mud and water from a tank. Mosses, dried flesh and powdered tubers of water-plants should be given them for food. For bedding they should be furnished with grasses and leaves of water-plants. Fresh water and food should be given every second or third day, and every seventh day the earthen pot should be changed. On the subject there is the following verse ·

Leeches which are very thin or thick or with their central portions thick, which move slowly or do not stick to the part to which they are applied, which drink little blood, or which are poisonous, are not fit for use. When about to apply leeches on a person who has got a disease curable by them, the patient should be made to sit or lie

also when they are seized or caught, let them be put away while all that which is in their own belly is being purged: also they ought not to be put on except in a place not healthy;

down. The affected part, if free from pain, should be rubbed with a little cowdung and earth. The leeches should then be taken hold of and smeared with a mixture of turmeric and mustard reduced to a paste with water. They should then be placed for a while in a cup of water, till they are relieved of their weariness and afterwards applied to the diseased part. *When being applied, their mouths should be left open and their bodies covered with fine white wet rags.*

If they do not bite, a drop of milk or blood should be applied to, or a small incision may be made on the diseased part. If even by these means a leech cannot be applied, it should be changed for another.

A leech is known to have fixed itself to the part when it raises its shoulder and bends its head like a horse-shoe. When fixed it should be covered

also anointments ought to be made around the place with paste that they may not touch the healthy place: also as often as leeches are applied, put over them a fine soaked cloth:

If a leech does not stick let the place be anointed with milk or with blood: if it still refuses to bite, let another be applied in the place of it:

with a piece of wet cloth and a little water sprinkled on it occasionally. If the part bitten by a leech itches or is painful, it is a sign that the leech is drawing pure blood and it should be removed from the part.

If from fondness for blood *but if*
it cannot be readily removed, *you wish that they fall off,*
a little rock-salt should sprinkle their heads.(mouths)
be sprinkled on its head. ‡ *with salts and keep them in*
a jar. †

There is thus unmistakable evidence here of the use of a chapter of the Susruta or some such work.

Then again several drugs, which are repeatedly mentioned in the Charaka and are almost exclusively Indian products, have been borrowed in the materia medica of Useibiah

‡ Dutt's Trans.

† The version of Rases, being in the "dog" Latin of the middle ages, is not always very intelligible to us.

and others. The following may be taken as examples : Pepper,¹ lac, nard,² liquorice, assafœtida qccimum, sanctum, bdellium, cinnamon, the chebule myrobalans, calamus acorus, agallacha,³ berberis asiatica, ⁴ myrrh, melia azadirechta, calotropis, (asclepias), and red sandal. To quote Gildemeister :

“ Ex. hac Indiae parte asportatur agallochum Kumârense, quod inde nomen cepit.” p. 156.

(1) Dioscorides also mentions the three peppers. Arabian physicians of the tenth century also describe their properties. See Dymock, Warden and Hooper's "Pharmacographia Indica," III. pp. 176-185.

(2) "Nardostachys jatamansi," the Nardin of Dioscorides, called also "Gangitis," because the Ganges flowed from the foot of the mountains where the plant grows : *ibid* II. p. 234.

(3) For the discussion of agallocha (sans. अगल्लोच), see also "Script. arab. de Reb. Ind.," pp. 65-72.

(4) The extract of the wood was also known to the Greeks under the name of Indian Lycium. "Pharm. Ind.," I. 65.

Cf. "Among the strictly Indian products, we have the two kinds of Pepper (long and round), Cardamoms and Ginger (?) . . . the "Dolichos," mentioned by Hippocrates and Theophrastus, as well as by later authors, is considered to be "Phaseolus Vulgaris, and to have been introduced from India in the time of Alexander." Royle: "Antiquity of Hindu Med.," Lond., 1837, p. 121.

"Abuldhali Sindius dum Indiae regiones describit, dicit :

' Negarunt quidem sodales mei nec tamen istud praestantissimum est.

"Quando laudabatur India Indaque sagitta in campo caedis.

"Per vitam meam ! terra est : in quam si pluvia decedit.

"Contingunt hyacinthi et uniones ei qui monilibus caret.

"Ibi originem habent muscus et camphora et ambarum et agallochum

"Et aromatum genera, quibus utuntur qui inodori sunt.

' Et odoramentorum species ,et myristica et spica nardi ;

' Ibi ebur et tectonae lignum, ibi lignum aloës et santalum

"Ibique est tutia montis instar longissimi." pp. 217-218.

That the Charaka should be changed by Arabic writers into "Sarak," Susruta into "Susrud," Nidána into "Badan," Astánga into "Asankar" and so forth, need not at all surprise us. Such transformations can well be explained on phonetic principles. Moreover,

one must remember that the Indian works translated into Arabic were sometimes derived from preëxisting Phelvi versions, and in the migrations through successive languages, the names often got frightfully disfigured. A notable instance of this kind is afforded by the fables of Pilpay (Kalila and Dimna¹) from which La Fontaine borrowed the idea of several of his fables as he himself acknowledges: "I shall only say, from a sense of gratitude, that I owe the largest portion of them to Pilpay, the Indian sage." It has now been made out that Pilpay or Bidpai is a corrupt form of the Sanskrit word "ṛidyápati" (master of learning).

Even long before the time of the Caliphs, India was the favourite resort of the students of medicine and other sciences. Thus Barzouhyeh, a contemporary of the celebrated

(1) ". . . . et malgré l'espece de transformation que ce livre a dû subir en passant de l'indien en pehlvi, du pehlvi en arabe, de l'arabe en persan, on y retrouve encore des caractères frappans de cette origin"—de Sacy: "Calila et Dimna ou Fables de Bidpai, (1816), p. 5.

Sassanian king Nashirván, (A. D. 531-572), visited India to acquire proficiency in the Indian sciences.¹

Thomson, Hoefer, Kopp, and Berthelot have done ample justice to the claims of the Arabians as the originators or, at any rate, as the propagators of alchemy in Europe in the middle ages. M. Berthelot, indeed, has recently shown that the ideas and theories, as regards alchemy, humoral pathology and physiology, which were promulgated in the writings of Geber, Rases, Avicenna, Bubacar and others, were essentially Greek in origin, though extended and improved upon by the Arabians. The French savant has, however, presented only one side of the

Arabian indebtedness to India ignored by the European historians of chemistry.

(1) “. que Barzouyèh dans sa jeunesse, avoit déjà fait un premier voyage dans l’Inde, pour y rechercher des substances médicinales et de simples, et que c’était dans ce voyage qu’il avoit acquis la connoissance de la langue et de l’écriture Indiennes” *ibid*, p. 23.

shield.¹ In short, European historians of chemistry have scarcely one word to say on the indebtedness of the Arabians to the Hindus, who contributed not a little to the making of a Rases, a Serapion, or an Avicenna, who, in turn, were the chief inspirers of the European iatro-chemists down to the 17th century.²

Prof. Sachau, the learned translator and

Prof. Sachau, however, does justice to the claims of India.

editor of Albérúni's India, however, does justice to the

(1) Cf. "—les Arabes, héritiers et traducteurs de la science grecque."—Berthelot: "La Chimie au moyen Âge," I., préface, ii. "Les sciences naturelles furent surtout étudiées aux ix^e et x^e siècles, dans la célèbre école des médecins syriens de Bagdad, attirés et protégés par leurs clients. Dioscoride, Galien, Paul d'Egine furent ainsi traduits du grec en syriaque, puis en arabe; parfois même traduits directement dans cette dernière langue," *ibid*, iv. "Les califes recherchaient les savants syriens, à cause de leur habileté médicale.....or toute leur science venait des Grecs" *ibid* II., Introduction, iji.

(2) Speaking of Albert the Great and Roger Bacon, Kopp writes: "beide haben aus derselben Quelle, den Arabern, geschöpft." "Gesch. d. chem." 1. 64. Draper equally ignores the contributions of the Hindus: *e.g.*, "The teachers of the Saracens were the Nestorians and the Jews." "Hist. Intell. Dev. of Europe," Vol. I. p. 384, ed. 1896.

claims of both Greece and India in this respect, when he remarks :—

“The cradle of Arabic literature is not Damascus but Bagdad, the protection necessary for its growth being afforded by the Caliphs of the house of Abbas.

“The foundation of Arabic literature was laid between 750-850 A.D. The development of a large literature with numerous ramifications carried out with foreign materials, as in Rome the *origines* of the national literature mostly point to Greek sources. Greece, Persia and India were taxed to help the sterility of the Arab mind.”

We cannot conclude this chapter better than sum up its substance in the words of Prof. Sachau :—

“What India has contributed reached Bagdad by two different roads. Part has come directly in translations from the Sanskrit, part has travelled through Eran, having originally been translated from Sanskrit (Pālī ? Prākṛit ?) into Persian, and farther from Persian into Arabic. In this way, *e.g.* the fables of Kālila and Dimna have been communicated to the Arabs, and a book on medicine, probably the famous Charaka *cf.* “Fihrist,” p. 303.

"In this communication between India and Bagdad we must not only distinguish between two different roads, but also between two different periods.

"As Sindh was under the actual rule of the Khalif Mansūr (A. D. 753-774), there came embassies from that part of India to Bagdad, and among them scholars, who brought along with them two books, the "Brahmasiddhānta" of Brahmagupta (Sindhind), and his "Khandakhādyaka" (Arkand). With the help of these pandits, Alfāzarī, perhaps also Yakub Ibn Tārik, translated them. Both works have been largely used, and have exercised a great influence. It was on this occasion that the Arabs first became acquainted with a scientific system of astronomy. They learned from Brahmagupta earlier than from Ptolemy.

"Another influx of Hindu learning took place under Harun, A. D. 786-808. The ministerial family Barmak, then at the zenith of their power had come with the ruling dynasty from Balkh, where an ancestor of theirs had been an official in the Buddhistic temple *Naubehār i. e. navavihāra*, the new temple (or monastery). The name Barmak is said to be of Indian descent, meaning *paramaka*, i. e. the superior (abbot of the *vihāra*?). Cf. Kern, "Geschichte des Buddhismus" in Indien, ii, 445,

543. Of course, the Barmak family had been converted, but their contemporaries never thought much of their profession of Islam, nor regarded it as genuine. Induced probably by family traditions, they sent scholars to India, there to study medicine and pharmacology. Besides, they engaged Hindu scholars to come to Bagdad, made them the chief physicians of their hospitals, and ordered them to translate from Sanskrit into Arabic, books on medicine, pharmacology, toxicology, philosophy, astrology and other subjects. Still in later centuries Muslim scholars sometimes travelled for the same purposes as the emissaries of the Barmak, *e.g.* Almuwaffak, not long before Albérūni's time ("Codex Vindobonensis, sive medici Abu Mansur liber fundamentorum pharmacologiæ, ed. Seligmann, Vienna, 1859, pp. 6, 10, and 15, 9.")

We shall finish with another appropriate extract from Prof. Macdonell's recent work¹ :—

"In Science, too, the debt of Europe to India has been considerable. There is in the first place, the great fact that the Indians invented the numerical figures

So also Prof. Macdonell.

(1) "Hist. Sans. Lit." p. 424.

used all over the world. The influence which the decimal system of reckoning dependent on those figures has had not only on mathematics, but on the progress of civilisation in general, can hardly be over-estimated. During the 8th and 9th centuries the Indians became the teachers in arithmetic and algebra of the Arabs, and through them of the nations of the West. Thus, though we call the latter science by an Arabic name, it is a gift we owe to India."

We have thus far attempted to present our readers with a brief, hurried and necessarily imperfect survey of the gradual evolution and development of Hindu medicine and alchemy from the Vedic age onward. We hope we have been justified in dividing this entire range into four distinct periods, each characterised by fairly well defined features. There are of course no sharp lines of demarcation—the one imperceptibly merging into the other. These are (1) The Ayurvedic Period ; (2) The Transitional period ; (3) The Tantric period ; (4) The Iatro-chemical period.

We shall now proceed to give a rough account of the chemical knowledge of each period—a more detailed description, especially of the Tantric period, being reserved for the second volume.

The Ayurvedic Period

(From the pre-Buddhistic Era to circa
800 A. D.)

CHAPTER I

The Constitution and Properties of Matter : the Atomic Theory

IT is not our purpose to discuss in the present volume the theories dominating Hindu medicine and, incidentally, chemistry. A concise preliminary summary of some of the salient features of the Sāṃkhya and Vaiśeṣika systems of philosophy is, however, absolutely needed in order to follow with advantage the excerpts given in this book from the Charaka, the Susruta and other works. In connection with this, it would also be interesting to compare the indebtedness of Hippocrates to the doctrines of Parmenides, Empedocles and other philosophers of the same school.¹

(1) "Œuvres d'Hippocrate" by E. Littré, Paris, 1839, Tome I. Intro. pp. 13 et seq. In connection with this chapter

Kanāda, the founder of the Vaiseshika system, chiefly occupied himself with the study of the properties of matter. The atomic theory, as propounded by him, has many points in common with that of the Greek philosopher Democritus. His theory of the propagation of sound cannot fail to excite our wonder and admiration even at this distant date. No less remarkable is his statement that *light and heat are only different forms of the same essential substance*. But Kanāda is anticipated in many material points by Kapila, the reputed originator of the Sāmkhya philosophy. With the purely metaphysical aspects of these systems we are not concerned here. Their theories of matter and its constitution alone fall within the scope of our present enquiry. We shall now briefly refer to some of their doctrines.

The Sāmkhya, in common with other systems of Hindu philosophy, teaches that salvation in after-life is only attainable by perfect knowledge. According to Kapila, there are three sources of knowledge which consists in right discrimination of the perceptible and imperceptible principles

the reader may also consult Gomperz' "Griechische Denker", vol. 1. ed. 1903, specially the articles: "Die Aerzte" pp. 221-254, and "Die Atomistischen Physiker", pp. 254-298.

of the material world from the immaterial soul. He enumerates these principles to be twenty-five in number. For our present purpose, however, a few of these only come within our purview. These we will present to our readers in the inimitable language of Colebrooke, whose masterly exposition of Hindu thought, though written nearly four scores of years ago, still retains its value and authoritative stamp¹ :—

TANMĀTRĀS OR PARTICLES.

“Five subtile particles, rudiments, or atoms, denominated Tanmātras ; perceptible to beings of a superior order, but unapprehended by the grosser senses of mankind : derived from the conscious principle, and themselves productive of the five grosser elements, earth, water, fire, air, and space.

FIVE ELEMENTS.

“Five elements, produced from the five elementary particles or rudiments. 1st. A diffused,

(1) Trans. Royal As. Soc., Vol. 1 pp. 19-43 and pp. 92-118
The European student who wishes to pursue the subject further may consult Max Müller's "Six Systems of Indian Philosophy" in which an ample and exhaustive bibliography will be found.

ethereal fluid (ākāśa), occupying space : it has the property of audibleness, being the vehicle of sound, derived from the sonorous rudiment or ethereal atom. 2nd. Air, which is endowed with the properties of audibleness and tangibility, being sensible to hearing and touch ; derived from the tangible rudiment or ærial atom. 3rd. Fire, which is invested with properties of audibleness, tangibility and colour ; sensible to hearing, touch and sight : derived from the colouring rudiment or igneous atom. 4th. Water, which possesses the properties of audibleness, tangibility, colour and savour ; being sensible to hearing, touch, sight and taste ; derived from the savoury rudiment or aqueous atom. 5th. Earth, which unites the properties of audibleness tangibility, colour, savour and odour ; being sensible to hearing touch, sight, taste and smell ; derived from the odorous rudiment or terrene atom.

ANIMATED ATOM.

“The notion of an animated atom seems to be a compromise between the refined dogma of an immaterial soul and the difficulty which a gross understanding finds in grasping the comprehension of individual existence, unattached to matter.

GROSSER BODY.

“The grosser body, with which a soul clad in its subtile person is invested for the purpose of fruition, is composed of the five elements, or of four, excluding the ethereal, according to some authorities ; or of one earth alone, according to others. That grosser body, propagated by generation, is perishable. The subtile person is more durable, transmigrating through successive bodies, which it assumes, as a mimic shifts his disguises to represent various characters.”

We now come to the treatment of the subject by Kanāda in his famous Vaiseshika system. Here also we are indebted to Colebrooke for the following summary. Kanāda arranges the objects of sense in six categories, viz., substance, quality, action, community, difference and aggregation. According to him :—

“I. Substance is the intimate cause of an aggregate effect or product : it is the site of qualities and of action ; or that in which qualities abide, and in which action takes place.

“Nine are enumerated, and no more are recognised. Darkness has been alleged by some

philosophers ; but it is no substance ; nor is body a distinct one ; nor gold which the Mīmāṃsakas affirm to be a peculiar substance.

“Those specified by Kanāda are :

EARTH.

“1. Earth, which besides qualities common to most substances (as number, quantity, individuality, conjunction, disjunction, priority, posteriority, gravity, fluidity and faculty of velocity and of elasticity), has colour, savour, odour and feel or temperature. Its distinguishing quality is smell ; and it is succinctly defined as a substance odorous. In some instances, as in gems, the smell is latent : but it becomes manifest by calcination.

“It is eternal, as atoms ; or transient, as aggregates. In either, those characteristic qualities are transitory, and are maturative, as affected by light and heat : for by union with it, whether latent or manifest, form, colour, taste, smell and temperature are in earth of any sort annulled, and other colour etc. introduced.

“Aggregates or products are either organised bodies, or organs of perception, or unorganic masses.

“Organised earthly bodies are of five sorts. The organ of smell is terreous. Unorganic masses

are stones lumps of clay, etc. The union of integrant parts is hard, soft or cumulative as stones, flowers, cotton, etc.

WATER.

"2. Water, which has the qualities of earth ; excepting smell, and with the addition of viscosity. Odour, when observable in water is adscititious, arising from mixture of earthy particles.

"The distinguishing quality of water is coolness. It is accordingly defined as a substance cool to the feel.

"It is eternal, as atoms ; transient, as aggregates. The qualities of the first are constant likewise ; those of the latter inconstant.

"Organic aqueous bodies are beings abiding in the realm of Varuṇa. The organ of taste is aqueous : witness the saliva. Unorganic waters are rivers, seas, rain, snow, hail, etc.

"It is by some maintained, that hail is pure water rendered solid by the supervention of an unseen virtue : others imagine its solidity to be owing to mixture of earthly particles.

LIGHT.

"3. Light is coloured, and illumines other substances ; and to the feel is hot : which is its

distinguishing quality. It is defined as a substance hot to the feel. [Heat, then, and light are identified as one substance.]*

"It has the qualities of earth except smell, taste, and gravity. It is eternal, as atoms; not so, as aggregates.

"Organic luminous bodies are beings abiding in the solar realm. The visual ray, which is the organ of sight, is lucid. Unorganic light is reckoned fourfold: earthy, celestial, alvine and mineral. Another distinction concerns sight and feel; as light or heat may be either latent or manifest, in respect of both sight and feel, or differently in regard to either. Thus fire is both seen and felt; the heat of hot water is felt but not seen; moonshine is seen, but not felt; the visual ray is neither seen nor felt. Terrestrious light is that, of which the fuel is earthy, as fire. Celestial is that of which the fuel is watery, as lightning and meteors of various sorts. Alvine is that of which the fuel is both earthy and watery: it is intestinal, which digests food and drink. Mineral is that which is found in pits, as gold. For some maintain that gold is solid light; or, at least that

* The sentence under bracket is Colebrooke's own.

the chief ingredient is light, which is rendered solid by mixture with some particles of earth. Were it mere earth, it might be calcined by fire strongly urged. Its light is not latent, but overpowered by the colour of the earthy particles, mixed with it. In the *Mīmāṃsā*, however, it is reckoned as a distinct substance, as before observed. ”

After giving an account of air and ether etc., Colebrooke proceeds with Kanāda's

(1) The term "element" was not generally used in the modern sense of a component of a compound ; rather it connoted certain properties characteristic of matter, e.g., coldness, dryness, heaviness, fluidity etc., thus it referred to certain qualities in the abstract. The Greek philosophers also held similar, if not identical, views. Cf. "Empedokles und die moderne Chemie." pp. 185-86 of "Griechische Denker" by Gomperz vol. I, ed. 1903. The following extract will also throw much light on the subject :

"The four so-called "elements"—air, water, earth and fire—were regarded by that intellectually great philosopher, Empedocles of Agrigent (about 440 B.C.), as the basis of the world ; but neither he himself nor Aristotle, who adopted these into his system of natural philosophy, looked upon them as different properties carried about by one original matter. Their chief qualities (the *primæ qualitates* of the later scholastics) he held to be those apparent to the touch, viz., warm, cold, dry, and moist. Each of the four so-called elements is characterised by the possession of two of these properties, air being warm and moist,

CONCEPTION OF THE SIMPLE, BINARY, TERTIARY, AND QUATERNARY ATOMS.

“ Material substances are by *Kanāda* considered to be primarily atoms ; and secondarily, aggregates. He maintains the eternity of atoms ; and their existence and aggregation are explained as follows :

“ The mote, which is seen in a sunbeam, is the smallest perceptible quantity. Being a substance and an effect, it must be composed of what is less than itself ; and this likewise is a substance and an effect ; for the component part of a substance that has magnitude must be an effect. This again must be composed of what is smaller ; and that smaller thing is an atom. It is simple and uncomposed ; else the series would be endless : and, were it pursued indefinitely, there would be no difference of magnitude between a mustard seed

water moist and cold, earth cold and dry, and fire dry and warm. The differences in the material world were, therefore, to be ascribed to the properties inherent in matter.

* * * *

“ Aristotle considered that his four elements were insufficient in themselves to explain the phenomena of nature ; he therefore assumed a fifth one, termed *ov'vía*, which he imagined to possess

and a mountain, a gnat and an elephant, each alike containing an infinity of particles. The ultimate atom then is simple.

“The first compound consists of two atoms: for one does not enter into composition; and there is no argument to prove, that more than two must, for incohesion, be united. The next consists of three double atoms; for, if only two were conjoined, magnitude would hardly ensue since it must be produced either by size or a number of particles: it cannot be their size and, therefore, it must be their number. Nor is there any reason for assuming the union of four double atoms, since three suffice to originate magnitude. The atom then is reckoned to be the sixth part of a mote visible in a sunbeam.

“Two earthly atoms, concurring by an unseen peculiar virtue, the creative will of God, or time, or other competent, cause, constitute a double atom of earth; and, by concourse of three binary atoms, a tertiary atom is produced; and by

an ethereal or immaterial nature and to permeate the whole world. As the “*quinta essentia*” this played an immense rôle among the followers of the Aristotelian doctrine in the Middle Ages, and gave rise to endless confusion, from the endeavours of many (who, unlike Aristotle, supposed it to be material) to isolate it.

concourse of four triple atoms, a quaternary atom ; and so on, to a gross, grosser, or grossest mass of earth : thus great earth is produced ; and in like manner, great water from aqueous atoms ; great light, from luminous ; and great air, from ærial. The qualities that belong to the effect are those which appertained to the integrant part, or primary particle, as its material cause ; and conversely, the qualities which belong to the cause are found in the effect.

“The dissolution of substances proceeds inversely. In the integrant parts of an aggregate substance resulting from composition, as in the potsherds of an earthen jar action is induced by pressure attended with velocity, or by simple pressure. Disjunction ensues ; whereby the union, which was the cause of incohesion of members, is annulled ; and the integral substance consisting of those members, is resolved into its parts,

“ There seems to be a high degree of probability in the assumption that Empedocles and Aristotle did not themselves deduce their theory of the elements, but derived it from other sources ; thus the oldest writings of India teach that the world consists of the four elements mentioned above, together with ether, which last is most likely related to Aristotle's *οὐραία*--Meyer's “ Hist. of Chem”. Eng. trans. ed. 1898. pp. 7-8.

and is destroyed : for it ceases to subsist as a whole.

QUALITY OF THE SUBSTANCE VIZ.,
COLOUR, SAVOUR, ETC.

‘II. Quality is closely united with substance ; not, however, as an intimate cause of it, nor consisting in motion ; but common : not a genus, yet appertaining to one. It is independent of conjunction and disjunction ; not the cause of them, not itself endued with qualities.

“Twenty-four are enumerated. Seventeen only are, indeed, specified in Kanāda’s aphorisms ; but the rest are understood.

“1. Colour. It is a peculiar quality to be apprehended only by sight ; and abides in three substances ; earth, water, and light. It is a characteristic quality of the last ; and, in that, is white and resplended. In water it is white, but without lustre. In the primary atoms of both it is perpetual ; in their products, not so. In earth it is variable ; and seven colours are distinguished : *viz.* white, yellow, green, red, black, tawny (or orange) and variegated. The varieties of these seven colours are many, unenumerated. The six simple colours occur in the atoms of the earth ;

and the seven, including variegated, in its double atoms, and more complex forms. The colour of integrant parts is the cause of colour in the integral substance.

“2 Savour. It is a peculiar quality, to be apprehended only by the organ of taste ; and abides in two substances, earth and water. It is a characteristic quality of the last ; and in it is sweet. It is perpetual in atoms of water ; not so in aqueous products. In earth it is variable, and six sorts are distinguished : sweet, bitter, pungent, astringent, acid, and saline.

“3. Odour. It is a peculiar quality, to be apprehended only by the organ of smell ; and abides in earth alone, being its distinguishing quality. In water, odour is adscititious, being induced by union with earthy particles ; as a clear crystal appears red by association with a hollyhock, or other flower of that hue. In air also it is adscititious : thus a breeze, which has blown over blossoms, musk, camphor, or other scented substances, wafts fragrant particles of the blossoms, etc. The flowers are not torn, nor the musk diminished ; because the parts are replaced by a reproductive unseen virtue. However, camphor and other volatile substances do waste.

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GRAVITATION.

"12. Gravity is the peculiar cause of primary descent or falling.

"It affects earth and water. Gold is affected by this quality, by reason of earth contained in it.

"In the absence of a countervailing cause, as adhesion, velocity, or some act of volition, descent results from this quality. Thus a cocoanut is withheld from falling by adhesion of the foot-stalk ; but, this impediment ceasing on maturity of the fruit, it falls.

"According to Udayana Āchārya, gravity is imperceptible, but to be inferred from the act of falling. Vallabha maintains that it is perceived in the position of a thing descending to a lower situation.

LEVITY.

"Levity is not a distinct quality, but the negation of gravity.

FLUIDITY.

"13. Fluidity is the cause of original trickling.

"It affects earth, light and water. It is natural and essential in water ; adscititious in earth and

light ; being induced by exhibition of fire in molten substances, as lac, gold etc.

“Fluidity is perceptible by external senses, sight and touch.

“In hail and ice, fluidity essentially subsists, but is obstructed by an impediment arising from an unseen virtue which renders the water solid.

VISCIDITY.

14. “Viscosity is the quality of clamminess and cause of agglutination. It abides in water only. In oil, liquid butter, etc., it results from the watery part of those liquids.

SOUND.

“15. Sound is a peculiar quality of the ethereal element, and is to be apprehended by the hearing. It abides in that element exclusively and is its characteristic quality. Two sorts are distinguished : articulate and musical.

THEORY OF THE PROPAGATION OF SOUND.

“To account for sound originating in one place being heard in another, it is observed, that sound is propagated by undulation, wave after wave,

radiating in every direction, from a centre, like the blossoms of a Nauclea. It is not the first, nor the intermediate wave, that is the sound heard: but the last that comes in contact with the organ of hearing: and therefore it is not quite correct to say, that a drum has been heard. Sound originates in conjunction, in disjunction, or in sound itself. The conjunction of cymbals, or that of a drum and stick, may serve to exemplify the first. It is the instrumental cause. The rustling of leaves is an instance of disjunction being the cause of sound. In some cases, sound becomes the cause of sound. In all, the conformity of wind or its calmness is a concomitant cause: for an adverse wind obstructs it. The material cause is in every case the ethereal fluid: and the conjunction of that with the sonorous subject is a concomitant cause."

It now only remains for us to furnish a précis of the atomic theory of Kanāda in the words of Max Müller:

ANUS OR ATOMS.

"What is thought to be peculiar to Kanāda, nay the distinguishing feature of his philosophy, is the theory of Anus or Atoms. They take the

place of the Tanmātrās in the Sāṃkhya philosophy. Though the idea of an atom is not unknown in the Nyāya-philosophy (Nyāya Sūtras, IV. 2, 4-25), it is nowhere so fully worked out as in the Vaiseshika. Kanāda argued that there must be somewhere a smallest thing that excludes further analysis. Without this admission, we should have a *regressus ad infinitum*, a most objectionable process in the eyes of all Indian philosophers. A mountain, he says, would not be larger than a mustard seed. These smallest and invisible particles are held by Kanāda to be eternal in themselves, but non-eternal as aggregates. As aggregates again they may be organised organs, and inorganic. Thus the human body is earth organised, the power of smelling is the earthly organ, stones are inorganic.

“It is, no doubt, very tempting to ascribe a Greek origin to Kanāda’s theory of atoms. But suppose that the atomic theory had really been borrowed from a Greek source, would it not be strange that Kanāda’s atoms are supposed never to assume visible dimensions till there is a combination of three double atoms (Tryanuka), neither the simple nor the double atoms being supposed to be visible by themselves. I do not

remember anything like this in Epicurean authors, and it seems to me to give quite an independent character to Kanāda's view of the nature of an atom.

"We are told that water, in its atomic state, is eternal, as an aggregate transient. Beings in the realm of Varuna (god of the sea) are organised, taste is the watery organ, rivers are water inorganic."

"Light in its atomic state is eternal, as an aggregate transient. There are organic luminous bodies in the sun, sight or the visual ray is the luminous organ, burning fires are inorganic.

"Air, again, is both atomic and an aggregate. Beings of the air, spirits, etc., are organised air; touch in the skin is the ærial organ, wind is inorganic air. Here it would seem as if we had something not very unlike the doctrine of Empedocles.

* * * But though we may discover the same thought in the philosophies of Kanāda and Empedocles, the form which it takes in India is characteristically different from its Greek form."

DATES OF THE PHILOSOPHICAL SŪTRAS—
THE QUESTION OF PRIORITY.

As regards the dates of the philosophical sūtras, nothing definite is known ; here, as in the subsequent portions of our history, we have to depend largely upon constructive chronology.

We quote below two short extracts from Professor Max Müller's "Indian Philosophy" which summarise all the information available at present on the subject :

"If we consider the state of philosophical thought in India such as it is represented to us in the Brāhmaṇas and Upanishads, and afterwards in the canonical books of the Buddhists, we cannot wonder that all attempts at fixing the dates of the six recognised systems of philosophy, nay even their mutual relationship, should hitherto have failed. It is true that Buddhism and Jainism were likewise but two philosophical systems out of many, and that it has been possible to fix their dates. But if in their case we know something about their dates and their historical development, this is chiefly due to the social and political importance which they acquired during the fifth, the

fourth, and the third centuries B. C., and not simply to their philosophical tenets. We know also that there were many teachers, contemporaries of Buddha, but they have left no traces in the literary history of India.

* * * *

"We cannot be far wrong therefore if we assign the gradual formation of the six systems of philosophy to the period from Buddha (5th century) to Asoka (third century), though we have to admit, particularly in the cases of Vedānta, Sāṃkhya and Yoga, a long previous development reaching back through Upanishads and Brāhmaṇas to the very hymns of the Rig Veda.

"It is equally difficult to fix the relative position of the great systems of philosophy, because, as I explained before, they quote each other mutually. With regard to the relation of Buddhism to the six orthodox systems it seems to me that all we can honestly say is that schools of philosophy handing down doctrines very similar to those of our six classical or orthodox systems are presupposed by the Buddhist Sūttas." (pp. 116—120)

As regards the question of priority, we shall also take the liberty to quote below from Prof.

Macdonell's "History of Sanskrit Literature":

"Turning to Philosophical Literature, we find that the early Greek and Indian Philosophers have many points in common. Some of the leading doctrines of the Eleatics, that God and the universe are one, that everything existing in multiplicity has no reality, that thinking and being are identical, are all to be found in the philosophy of the Upanishads and the Vedānta system, which is its outcome. Again, the doctrine of Empedocles, that nothing can arise which has not existed before, and that nothing existing can be annihilated, has its exact parallel in the characteristic doctrine of the Sāṃkhya system about the eternity and indestructibility of matter. According to Greek tradition, Thales, Empedocles, Anaxagoras, Democritus, and others undertook journeys to Oriental countries in order to study philosophy. Hence there is at least the historical possibility of the Greeks having been influenced by Indian thought through Persia.

"Whatever may be the truth in the cases just mentioned, the dependence of Pythagoras on Indian philosophy and science certainly seems to have a high degree of probability. Almost all the doctrines ascribed to him, religious, philoso-

phical, mathematical were known in India in the sixth century B. C. The coincidences are so numerous that their cumulative force becomes considerable. The transmigration theory, the assumption of five elements the Pythagorean theorem in geometry, the prohibition as to eating beans, the religio-philosophical character of the Pythagorean fraternity and the mystical speculations of the Pythagorean school, all have their close parallels in ancient India. The doctrine of metempsychosis in the case of Pythagoras appears without any connection or explanatory background and was regarded by the Greeks as of foreign origin. He could not have derived it from Egypt, as it was not known to the ancient Egyptians. In spite, however, of the later tradition, it seems impossible that Pythagoras should have made his way to India at so early a date, but he could quite well have met Indians in Persia.”¹

(1) “History of Sanskrit Literature” pp. 421—22. Colebrooke himself sums up his views in these words :—“I should be disposed to conclude that the Indians were in this instance teachers than learners.” “Trans. Roy. As. Soc.,” Vol. 1., p. 579. Prof. H. H. Wilson observes :—“that the Hindus derived any of their philosophical ideas from the Greek seems very improbable, and if there is any borrowing in the case, the latter were most probably indebted to the former.” Preface to the *Sāṃkhya Kārikā* (1837) p. ix.

CHAPTER II

Chemistry in the Charaka and the Susruta

THE CHARAKA

[The subject-matter in the first few extracts in this chapter is practically based upon the Vaiseshika system ; see ante pp. 6 *et seq.*]

THE TASTES—THE METALS AND THEIR CALCES

“The object of the tongue is taste. Water and earth are the objective existences in which taste inheres. In its manifestation and as regards particular kinds of it, space, air and light are also its adjuncts. Sweet, sour, salt, pungent, bitter and astringent, these are regarded as the sixfold catalogue of tastes. * * * Objects are again known to be of three kinds, *viz.*, animal products, vegetable products and products appertaining to the earth. Honey, vaccine, secretions, bile, fat, marrow, blood, flesh, excreta, urine, skin, semen, bones, tendons, horns, nails, hoofs, hair, bristles and

the bright pigment called *Gorochanā*,¹ are used (as drugs) among animal products. Gold, the five metals and their ordure [*i.e.* their calces, the five metals *viz.*, silver, copper, lead, tin and iron], sand, lime, red arsenic, gems, salt, red chalk and antimony, are indicated as drugs appertaining to the earth."²

A DISCOURSE ON THE TASTES—THEIR RELATIONSHIP TO THE FIVE PRIMAL ELEMENTS—THE NATURE OF THE ALKALI

"Once on a time, the son of Atri, and Bhadrakāpyas Sākuntēya and the full-eyed Maudgalya, and the golden-eyed Kausika, the sinless Bhāradvāja otherwise called Kumārasiras, the blessed king Vāryovida, that foremost of all intelligent men Nimi, the ruler of the Videhas, Vāḍisa of high intelligence, and Kāmkhāyana-vālhika, that foremost of all physicians of the Vālhika country,—these Rishis, all of whom were old in years and learning and all of whom had subjugated their souls, came together to the delightful Chaitraratha woods, desirous of passing a few days in enjoyment

(1) Concretions found in the gall bladder of the ox.

(2) A. C. Kaviratna's Translation of "Charaka Samhitā," pp. 6-7.

and pleasure. As those *Rishis* conversant with every topic were seated there, the following discourse of grave import took place among them on the subject of the proper ascertainment of the (different) tastes and food.

“There is one kind of taste said Bhadrakāpya ; which persons skilled in the subject regard as are of the five subjects of the senses, *viz.*, that which relates to the tongue. That, again, is not different from water.

“The Brāhmaṇa Śākuntēya said there are two tastes, their virtues being that one of them cuts or removes from the body all bad humours or ingredients, and the other only checks or curbs them.

“There are three tastes, said the full-eyed Maudgalya. Their virtues are cutting, curbing, and both. .

“There are four tastes, said the golden-eyed Kausika. They are agreeable and beneficial, and agreeable and non-beneficial, disagreeable and beneficial.

“There are five tastes, said Kumārasira-Bharadvāja. They appertain to Earth, Water, Fire, Air and Ether (or Space).

“There are six tastes, said the royal sage

Vāryovida. They are heavy, light, cold, hot, oily and dry.

"There are seven tastes, said Nimi, the ruler of the Videhas. They are sweet, sour, saltish, pungent, bitter, astringent and alkaline.

"There are eight tastes, said Vādīsa-Dhāmārgava. They are sweet, sour, saltish, pungent, bitter, astringent, alkaline and that which remains in an unmanifest form.

"The tastes are infinite in number, said Kām-khāyana, foremost among the physicians of the Vāl̥hika country, in consequence of the infinite variety of their virtues, operations or effects and methods of corrections (or mixture for adding to their virtues, etc.,).

"The illustrious son of Atri, *viz.*, Punarvasu, said that the number of tastes is truly six. They are sweet, sour, saltish, pungent, bitter and astringent. The source from which these six flow, *i. e.* their origin, is water. Their operations or effects are of two kinds, *viz.*, cutting and curbing. In consequence, again, of mixture or combination, they become both cutting and curbing at the same time. Agreeable and disagreeable are their divisions that depend upon the likes and dislikes of men. Beneficial and non-beneficial are their

powers. The refuge of the tastes are the modifications of the five primal elements (of Earth, Water, Fire, Air and Ether or Space). The tastes, again, depend upon the (original) nature of their refuge, the modifications of that refuge, combinations of the substances that form their refuge, as also place, and time.¹

“The virtues or properties (attaching to the tastes) occur in those which constitute the refuge (of the tastes), called objects. Those virtues are heavy, light, cold, warm, oily, dry and others.

“*Kshāra* (alkali) is so called from its being produced by *ksharana* (dropping down or straining). This is not a taste. It is, on the other hand, an object. It is, in fact, produced from many kinds of taste. Hence, it has many tastes. Among them, pungent and saline predominate. It is composed of many objects of the senses. It is manufactured with the aid of different processes.

(1) The modifications of the five primal elements constitute the refuge of the tastes. Every substance is formed by modifications of those elements. What is said, therefore, is that material substances are the refuge of the tastes, *i.e.* the tastes inhere in them.

"At the outset, however, we shall say something referring to the diversity of objects (which are the refuse of the tastes). All objects are the results of the combinations of five primal elements (*viz.*, Earth, Water, Fire, Air and Ether or Space). As regards Medical Science, objects are of two kinds, *viz.*, those endowed with animation and those that are inanimate. The attributes which inhere in objects are sound, &c., heaviness &c., ending with solubility."¹

We now quote only a few typical instances of mineral and metallic preparations.

THE FIVE KINDS OF SALTS

"The five kinds of salts *viz.*, *sauvarchala*, *saindhava*, *vit*, *aubhida*, with *sāmudra*." [See Index under the respective headings].

MINERALS FOR EXTERNAL APPLICATION

"Sulphate of copper, sulphate of iron, *realgar*, *orpiment* and sulphur in combination with vegetable drugs are prescribed for external application in ringworm, eczema, leprosy, &c."²

(1) Kaviratna's Trans., pp. 295-99.

(2) Sūtra, Ch. III, 4-5.

THE EIGHT VARIETIES OF URINE

"The eight varieties of urine are those of the sheep, the goat, the cow, the buffalo, the elephant, the camel, the horse and the ass." ¹

PREPARATION OF KSHĀRA (ALKALI)

"A young *butea frondosa* is to be cut to pieces and dried and finally reduced to ashes. The ash is to be lixiviated with four or six times its weight of water and strained (through linen) 21 times." ²

PILL IRON COMPOUND

"Into the composition of pill iron compound pyrites and the rust of iron enter." ³

A COLLYRIUM

"The ingredients of a collyrium are conch-shell, coral, lapis lazuli, iron, copper, the bone of the

(1) Ibid, Ch. I, 43.

(2) Chikitsā, Ch. XXIII, 26.

(3) Ibid, Ch., XVI 28.

frog, sulphide of antimony and the seed *hyperanthera morunga*.”¹

[The first five articles are interpreted as meaning the calces thereof.]

POWDER OF PEARL COMPOUND

“Among the constituents we have, pearl, sulphur, powder of iron, copper and silver.”²

[The text does not precisely say whether the metals are to be used *as such* or *as killed* by being roasted with sulphur. The Hindu physicians however always take them in the latter sense.]

IRON, GOLD AND SILVER TONICS

“A thin iron plate is to be made red hot and plunged into the decoction of the myrobalans, cow’s urine, the solution of ‘the salts’, the solution of the alkali extracted from the ash of *butea frondosa*; *i.e.* made red hot and plunged into one of the above liquids at a time. When the iron becomes black like collyrium it is to be powdered. * * *

(1) Ibid, Ch, XXVI, 123.

(2) Chikitsá, Ch. XVII, 40.

The references are according to the edition of Kavirajes D. N. Sen and U. N. Sen.

"The same process to be adopted in the case of gold and silver."¹

RASĀYANA DEFINED

"Medicines are of two kinds : the one promotes the strength and vitality of the healthy, the other cures diseases.

"Whatever promotes longevity, retentive memory, health, virility, &c. is called Rāsāyana."²

THE SUSRUTA

PREPARATION AND USE OF ALKALIES AND

ALKALINE CAUSTICS.³

"Of all cutting instruments and accessory cutting instruments, caustics are superior inasmuch as they perform the work of incisions, punctures and scarifications, relieve derangements of the three humours, *viz.*, air, bile and phlegm, and uniformly affect the diseased part to which they are applied. *Kshāra* (caustics) are so called

(1) Chikitsā Ch. I. 5, pp. 497-98.

(2) Ibid Ch. I. pp. 2-6.

(3) We have adopted Udoy Chand Dutta's Translation of Chs. XI and XIV with certain corrections here and there.

because they remove diseased parts and destroy the skin and flesh. From being composed of numerous medicines they can affect the three humours. Caustics being white in colour are cooling or of lunar origin.¹ This origin is not inconsistent with their burning, escharotic and lacerating properties. Being composed of numerous heating medicines, caustics are acrid, hot and pungent. They promote suppuration, destroy parts, improve unhealthy sores and promote granulation, dry up discharge, stop bleeding and abrade the skin. Their internal use removes worms, acidity, phlegm, skin diseases, some poisons and corpulence. Their excessive use causes impotence.

“ Alkalies are of two sorts, namely, for external application and internal administration. They are used externally in the skin diseases called *kustha*, in keloid, ringworm leucoderma, lepra, fistula-in-ano, tumours, unhealthy ulcers, sinuses, condyloma, moles, chloasma, brown spots on the face, warts, external inflammations, worms, poisons and piles, and in the seven following diseases of the mouth

(1) The reader will not fail to notice that silver nitrate is, in the language of Western Alchemy, named *lunar caustic*.

namely, *upajihvā* (ranula), *adhijihvā* (tumour on the tongue), *upakusa* (inflammation of the gum), *danta-vaidarbha* (inflammation of the gum from injury), and the three sorts of rohinī or inflammation of the throat. In these diseases of the mouth, accessory instruments, in the shape of caustics only, should be used. Alkaline solutions are administered internally in chronic or slow poisoning, abdominal tumours, ascites, loss of appetite, indigestion, disinclination for food, tympanitis, urinary deposits, calculi, internal or deep-seated inflammation, intestinal worms, poisoning and piles. Alkalies do not agree with children, old and weak people, and persons having a tendency to hæmorrhage from internal organs, or a bilious temperament. They are injurious in fever, giddiness, intoxication, fainting, amaurosis and such other diseases.

“Alkalies for escharotic use are prepared like other alkalies by straining alkaline solutions as elsewhere explained in detail. They are made of three strengths, namely, weak, moderate and strong. He who wishes to prepare alkalies should in an auspicious day in autumn, fasting and in pure body, select a middle-aged, large-sized, uninjured *ghantāpātali* tree with black flowers (*Schrebera swietenoides*) growing on an approved spot on a mountain, and

address it with certain *mantras* or incantations as a preliminary ceremony called *adhivāsa*. Next day the tree should be cut or killed after reciting the following *mantra* or prayer: "Oh you with great fiery power may not thy strength be lost! Oh you auspicious tree, stay here and accomplish my work. After accomplishing my work you will go to heaven." Then the ceremony of *homa*, or burning the sacrificial fire, should be performed with one hundred red flowers. The tree should then be cut to pieces and piled in a place free from wind. Some limestone should be placed on the pile which should be set on fire by stalks of *Sesamum Indicum*. When the fire is extinguished, the ashes of the *ghantāpātali* tree and the burnt lime should be kept separate. In the same way the following trees may be burnt with their root, branches, leaves and fruits for the preparation of alkalies,¹ namely :

Kuṭaja	Hollarrhena antidysenterica.
Palāsa	Butea frondosa.
Aśvakarna	Shorea robusta.
Pāṇibhadraka	Erythrina indica.
Vibhītaka	Terminalia bellarica.

(1) Cf. Rasārṇava, below, where the standard "plant ashes" are enumerated.

Āragvadha	Cassia fistula.
Tilvaka	Symplocos racemosa.
Arka	Calotropis gigantea.
Snuhī	Euphorbia neriifolia.
Apāmārga	Achyranthes aspera.
Pātalā	Stereospermum suaveolens.
Naktamāla	Pongamia glabra.
Vrīsha	Justicia adhatoda.
Kadalī	Musa sapientum.
Chitraka	Plumbago zeylanica.
Pūtika	Guilandina bonducella.
Indravriksha	Terminalia arjuna.
Āsphota	Salvadora persica.
Asvamāraka	Nerium odorum.
Saptachṇhada	Alstonia scholaris.
Agni mantha	Premna serratifolia.
Gunjā	Abrus precatorius.
4 sorts of Kosā 4 varieties of Luffa amara."	

LIXIVIATION OF THE ASHES

"Thirty two seers of ashes should be stirred or mixed with six times their quantity of water or cow's urine and the mixture strained through cloth. This should be repeated twenty-one times. The strained fluid should then be boiled slowly in a large pan and agitated with a ladle. When the fluid becomes clear,

pungent and soapy to the feel, it should be removed from the fire and strained through cloth. The filtrate¹ being thrown away, the strained fluid should be again boiled. From this alkaline solution take three quarters of a seer."

RENDERING THE ALKALI CAUSTIC

"Then take eight palas each of Banduc nut, burnt limestone, conch shells, and bivalve shells and heat them in an iron pan till they are of the colour of fire. Then moisten them in the same vessel with the above-mentioned three-quarters of a seer of alkaline water and reduce them to powder. This powder should be thrown on sixty-four seers of the alkaline water and boiled with constant and careful agitation by the ladle. Care should be taken that the solution is neither too thick nor thin."

HOW TO STORE UP THE ALKALI

"When reduced to proper consistence,¹ the solution should be removed from the fire and poured into an iron jar. The opening or mouth of

(1) This is evidently a mistake. According to the original text, it should be "the dregs" *i. e.* the precipitate.

the jar should be covered, and should be kept in a secluded place. This preparation is called *madhyama* kshāra or alkaline caustic of middling strength. When the alkaline water is simply boiled to the proper consistence without the addition of burnt shells, &c., the preparation is called *mridu*¹ kshāra or weak alkaline solution. The strong alkaline caustic is prepared by boiling the weak solution with two tolaks each in fine powder of such of the under-mentioned ingredients as are available, namely :—

Dantī,	Baliospermum montanum.
Dravantī	Salvinia cucullata.
Chitraka	Plumbago zeylanica.
Lāngalīkī	Gloriosa superba.
Pūtika	Guilandina bonducell.
Kanaka	Salvinia cucullata.
Kshīrī	Cleome felina.
Vachā	Acorus calamus.

“Aconite root, carbonate of soda, asafoetida, black salt and corals.

“This solution is used for bringing to a head or opening abscesses. These three varieties of alka-

(1) “Mridu” may be rendered more accurately as “mild.”

lies should be used according to the state of the disease. In weak persons, the alkaline water without the addition of other caustic ingredients, should be applied to strengthen the parts."

CHARACTERISTICS OF THE GOOD AND THE BAD ALKALI

On this subject there are the following verses :

" Good alkaline caustics should be neither too strong nor too weak. They should be white in colour, smooth and soapy to the touch, should not spread beyond where they are applied, and act rapidly and successfully. These are the eight good properties of caustics. Their bad qualities consist in their being too weak or cool, too strong or hot, too slippery and spreading, too thick or too under-boiled, or they may be deficient in ingredients.

" In applying caustic to a patient suffering from a disease curable by this remedy, he should be made to sit in a spacious place, protected from wind and sun. The physician should then procure the instruments or necessary articles according to the rules laid down in the fifth chapter. He should then examine the diseased part, rub, scarify or scratch it, and then apply the caustic by means of a probe, and

wait for the space of time required to utter one hundred words. The diseased part turns black on the application of the caustic which is a sign of its having been burnt. The application of some acid mixed with clarified butter or honey relieves the pain. If from the thickness of the burnt part. it does not fall off, the following application should be thoroughly applied to it, namely, equal parts of tamarind pulp, of the refuse of *kānjika* (fermented rice water i. e. crude vinegar), sesamum seeds and liquorice root rubbed together into a paste. Sesamum seeds and liquorice root rubbed together with clarified butter promotes granulation in ulcers."

WHY THE ACID NEUTRALISES THE ALKALI

"If you question, my son! how is it that the application of the pungent acid of *kānjika* relieves the burning of the fire-like hot alkaline caustic, then hear the following explanation from me. Alkalies possess all the tastes except that of the acid. The acrid taste prevails in it and the saline one to a less degree (cf. *ante* p. 28). The sharp saline taste when mixed with acid becomes very mild, and gives up its sharp quality. From this modification of the saline taste, the pain of caustics is relieved just as fire is extinguished by water."

MILD AND CAUSTIC ALKALIES

It will be noticed that there is a distinct mention of "mild" and "caustic" alkalies in the body of the text. The process of lixiviating the ashes and rendering the lye caustic by the addition of lime leaves very little to improve upon, and appears almost scientific compared to the crude method to which M. Berthelot pays a high tribute :

"Fabrication de la Lessive :—Quatre muids de cendres sont répartis entre deux cuiviers, percés de trous au fond. Autour du trou le plus petit, du côté intérieur, mets une petite quantité de foin, pour que la cendre n'obstrue pas le trou. Remplis d'eau le premier des cuiviers ; recueille le liquide filtré qui en découle pendant toute la nuit et mets-le dans le second cuvier ; grave ce qui filtre de ce second cuvier. Mets d'autre cendre (dans un troisième cuvier). Epiuse-la et il se forme une liqueur pareille au nard couleur d'or. Verse-la dans un quatrième cuvier. La liqueur devient piquante et forte : telle est la lessive particulière." "Coll. d. Alch. Grecs" III. trad. p. 357.

We reproduce the remarks of M. Berthelot on the above: "On a regardé comme modernes les procédés de lixiviation méthodique, usités pour

exprimer les cendres et les matériaux salpêtrés : le passage suivant, tiré du manuscrit de Saint-Marc, montre que ces procédés remontent au XI^e siècle et sans doute au delà."—"Chimie des Anciens" p. 284.

DESCRIPTION OF BLOOD

(Chapter XIV of Sūtrasthānam)

"The four varieties of food derived from the five elements and having the six tastes, the two properties of heat and cold or according to some, eight properties and many qualities when taken in moderation and thoroughly digested, produces a fine substance imbued with energy and fire. This is called *rasa* (chyle). The heart is the seat of the *rasa* or chyle. From the heart it proceeds through 24 arteries, namely, ten ascending, ten descending, and four transverse to all parts of the body. By some unseen cause or destiny, this chyle continually satiates, increases, nourishes and supports the body and keeps it alive. The motion of this chyle throughout the body is inferred from the processes of decline, increase, and diseased condition of the different portions of the body. It may be asked whether this chyle which pervades all the external parts of the body, the three humours, the tissues,

including the blood and the receptacles of the secretions, is endowed with the property of heat or cold. As this chyle is a circulating fluid, and as it softens, vitalises, supports and nourishes the body, it should be known to possess the cooling property. This watery fluid no doubt assumes a red colour in the liver and spleen, that is, it is converted into blood in these organs. On this subject there is the following verse :

“The *rasa* (chyle) of living beings is coloured red by healthy bile. This coloured fluid is called blood. The blood excreted by women and called the menstrual fluid is derived also from this *rasa*. This menstruation, coming at the age of twelve, ceases at the age of fifty.

“The menstrual fluid is endowed with the property of heat, owing to the womb being possessed of both the properties of heat and cold. Other writers say that the blood of living beings is composed of the five elements. The five qualities of the five elements as seen in blood are as follows, namely, fleshy smell, liquidity, red colour, tendency to trickle or ooze, and lightness.’ Blood is produced

(1) Cf. *ante* pp. 6-7 under Vaiseshika Philosophy.

from chyle, flesh from blood, fat from flesh, bones from fat, marrow from bones, and lastly the semen is produced from marrow. The chyle produced from food and drink nourishes these constituent parts of the body. Living beings are produced from the *rasa* ; hence sensible people should carefully preserve this *rasa* by conforming to the proper rules of diet and regimen.”¹

ON THE COLLECTION OF DRUGS

(Chapter XXXVIII : Sūtrashānam)

37 classes of vegetable drugs are mentioned which chiefly constitute the *Materia Medica*. There is only one sloka in which the six metals *viz.*, tin, lead copper, silver, *krishnaloha* (iron) and gold, and their calces are recommended.

THE SALTS

Rock-salt, sea-salt, bit, *sauvarchala*, *romaka* and *audbhid*, &c. (see *ante* p. 29).

(1) The reader may compare the above theories on the Chemistry and Physiology of Digestion and Nutrition with those of Geber. *Vide* " *Traité d'Alchimie Arabe*, " trad. pp. 201-3.

THE ALKALIES

Yavakshāra (factitious carbonate of potash), sārjikākshāra¹ (trona or natron) ; the alkaline solution prepared according to directions given in Ch. XI ; and borax.

Internal administration of alkali is recommended for dissolving the stones or gravels (urinary calculi).

INTERNAL USE OF LEAD AND TIN

Lead and tin are described as vermifuge—a property also accepted by the later Iatro-chemists.

Powdered tin rubbed for seven days together with the creamy portion of curd is recommended for internal administration.

MINERALS FOR EXTERNAL APPLICATION

For the treatment of ulcer an external application of sulphate of copper, sulphate of iron, orpiment and realgar, &c., is prescribed.

(1) From the time of the Charaka and the Susruta, Hindu Pharmacy has always recognised these two alkalies as distinct.

Another recipe includes alum-earth, red-ochre, sulphate of copper, yellowish (basic) sulphate of iron, rock-salt, orpiment and realgar. ¹

ROASTING OF IRON AND OTHER METALS, SO AS TO RENDER THEM FIT FOR INTERNAL

ADMINISTRATION.

Thin leaves of cast iron are to be smeared with the levigated powder of "the salt" and heated in the fire of the cow-dung cakes and then plunged into a decoction of the myrobalans and asafoetida. This process is to be repeated 16 times. The leaves are then to be ignited in the fire of the wood of *mimosa catechu* and afterwards finely powdered and passed through linen of fine texture.

The above process is equally applicable to the roasting of the other metals. ²

THE ORIGIN OF BITUMEN

The origin of bitumen is much the same as in the Charaka and the Bower Ms. ; the only difference

(1) Chikitsasthānam Ch. XIX, 37, ed. J. Vidyāsāgara.

(2) See Note on the "Metals and their Salts" p. 48

being that, according to Susruta, bitumen is related to six instead of four metals (see below p. 53).

IRON PYRITES

Iron Pyrites are collected on the bank of the river Tāpī, of the lustre of gold and silver respectively (see below under "Rasaratnasamuchchaya", Bk. II, 77-81 and prescribed in the treatments of diabetes, leprosy, &c.

GOLD DUST

Gold dust, mixed with lotus seed, honey, &c. is used as a tonic.

THE POISONS

The Poisons are classified as animal, vegetable and mineral respectively. Under the last we have *Phenasma bhasma*¹ and orpiment.

(1) It is sometimes taken to mean white arsenic; "but it is very doubtful if Susruta meant any native white arsenic by it. The derivation of the term implies that it was obtained by roasting some sort of stone or ore." Dutt.

USE OF MERCURY

The only references to mercury, which are however very vague, are तारः सुतारः समुरेन्द्रगापः सर्व्वश्च तुल्यः कुर्व्विन्द गागः ; and : रक्तं श्वतं चन्दनं पारदश्च काकोल्यादिः श्वोरपिष्टश्च वर्गः ।

NOTE ON THE METALS AND THEIR
SALTS (अथःशक्ति) ¹

Six metals are recognised, namely : tin, iron, lead, copper, silver and gold.² The thin leaves of the metals by being plastered over with a paste of "the salts" (see p. 46) including common salt, salt-petre and sulphate of magnesia and afterwards subjected to roasting were no doubt converted into their respective oxides, chlorides or oxy-chlorides as the case may be. We have thus in

(1) अत ऊर्ध्वमथस्तूतोर्वक्ष्यामः । तौत्र्यलाहपवाणि तनूनि लवनवर्ग-
प्रेदिमानि गोमयाधिप्रतमानि * * * सूक्ष्मशूर्णानि कारयेत् । Chikit., Ch.
X, 9.

(2) वर्षादिनाम्बु, लोहानी वक्ष्याम् । Chikit., Ch. XIII, 3.

वपुसोसताम्बरजतक्रयलोहसुवर्णानि । Sūtra., Ch.
XXXVIII, 56.

the Susruta a crude and imperfect, but all the same *potentially modern*, process for the preparation of the metallic salts. The much reputed "potable gold" in the shape of the chloride of the metal was probably in this way obtained. It will be interesting to note the successive stages in the evolution of the chemical processes as we proceed. (See below especially under "Chemistry in Rasār-nava," where the mixture of the salts is technically named "vidā" and consists of green vitriol, alum, common salt, salt-petre, &c.).

The reader will find an analogy in the ancient Egyptian and Greek methods as preserved in the Leyden Parchment, one or two extracts from which cannot fail to be of interest. It may be added by way of explanation that mineral acids being unknown to the ancients they had often to take recourse to the roundabout way of heating metals in combination with a mixture of blue vitriol, copperas, common salt and so on (see under "Mineral Acids") in order to get their salts.

"Ayant pris quatre paillettes d'or, faites-en une lame, chauffez-la et trempez-la dans de la couperose broyée avec de l'eau et avec une autre (couperose) sèche, battez (une partie)...une autre avec la matière mélangée: déversez la rouille et jetez dans..."

“ Il y a là deux recettes distinctes. Dans toutes deux figure le sulfate de cuivre plus ou moins ferrugineux, sous les noms de *chalcanthon* ou couperose et de *sory*. La seconde recette semble un fragment mutilé d'une formule plus étendue. La première présente une grande ressemblance avec une formule donnée dans Pline pour préparer un remède avec l'or, en communiquant aux objets torréfiés avec lui une propriété spécifique active, désignée par Pline sous nom de *virus* *.

* * ...ce qui complète le rapprochement entre la formule de Pline et celle du papyrus. Voici les paroles de Pline ;

“ On torréfie l'or dans un vase de terre, avec deux fois son poids de sel et trois fois son poids de *misy* ; puis on répète l'opération avec 2 parties de sel et 1 partie de la pierre appelée schiste. De cette façon, il donne des propriétés actives aux substances chauffées avec lui, tout en demeurant pur et intact. Le résidu est une cendre que l'on conserve dans un vase de terre.”

“ Pline ajoute que l'on emploie ce résidu comme remède. L'efficacité de l'or, le plus parfait des corps, contre les maladies et contre les maléfices est un vieux préjugé. De là, au moyen âge, l'idée de l'or potable. La préparation indiquée par Pline

devait contenir less métaux étrangers à l'or, sous forme de chlorures ou d'oxychlorures. Renfermait-elle aussi un sel d'or ? A la rigueur, il se pourrait que le chlorure de sodium, en présence des sels basiques de peroxyde de fer, ou même du bioxyde de cuivre, dégagât du chlore, susceptible d'attaquer l'or métallique ou allié, en formant du chlorure d'or, ou plutôt un chlorure double de ce métal. Mais la chose n'est pas démontrée. En tous cas, l'or se trouve affiné dans l'opération précédente."¹

(1) "Coll. des Anciens Alch. Grecs," Vol. I., pp. 14-15.

CHAPTER III

Chemistry in the Bower Ms.

THE ALKALIES

The alkalies in the Bower Ms. are the two carbonates of potash and soda. (Yavakshāra and Sarjikākshāra)

FUMES OF HORN

The fumes of horn are recommended as giving relief in hiccough. [Practically the same as "spirits of hartshorn."]

KSHĀRATAILA

"Oil, boiled with the ashes of long pepper, is a remedy for ear diseases" (Pt. ii. fasc. ii. p. 131). [Cf. The formula given in Chakrapāṇi (see p. 63)]

FORMULA FOR HAIR-DYE

Sulphates of copper and iron, boiled with the oil of belleric myrobalans * * * are used as a

remedy for turning grey hair into black (ibid ; p. 162).

RASAYANA DEFINED

It is called Rasāyana because it has a beneficial effect on *Rasa* or chyle and other elements of the body. Cf. p. 32.

THE DOCTRINE OF BITUMEN¹

Bitumen is produced from the following four metals : Gold, copper, silver and iron. Gold and other metals in the mountains, when heated by the sun, emit their impurities, oil-like, heavy and clay-like : these are the bitumen.

A LINCTUS

With certain vegetable drugs and "riparian sulphide of antimony,"² a linctus is made up with honey into a paste. (Pt. ii. fasc. 11. p. 123)

(1) The whole of this chapter, in a practically identical recension, is found in the Charaka. See Bower Ms., Pt. II., fasc. ii., ch. xii., p. 167.

(2) Srotaja anjana ; it is one of the five kinds of anjana or substances used for collyriums. The word literally means produced from a river, especially from the Yamuna. See Garbe's "Indische Mineralien," p. 54.

FORMULÆ FOR EYE-OINTMENT

Red ochre, rasôl, galena, realgar, calx of brass
(रेतिकुसुम) in equal parts...

With pepper and calx (of brass) one should
boil gold on a slow fire together with clarified
butter.¹

(2) The Bower Ms., Pt. I., verses 110 and 111.

CHAPTER IV

Chemistry In the Vagbhata.

A typical example is contained in the following recipe :

Sulphate of copper, red ochre, realgar, orpiment sulphate of iron, &c., are recommended for external application for genital sores.

PREPARATIONS OF GOLD, SILVER, COPPER, IRON AND LEAD

Gold, copper, silver, iron or tin are to be taken with the myrobalans, rock-salt and honey, &c.

Gold, silver, copper and iron are to be taken in conjunction with bitumen and milk.

Take 64 parts of stibium¹ and one part each of

(1) “ “**स्तीर्णजना**” ” Srotonjana is evidently stibnite or the native sulphide of antimony (See p. 53); Dutt translates it, we know not on what grounds, as calx-spar.

copper, iron, silver and gold ; now roast them in a closed crucible, &c.¹

Take 30 parts of lead, 5 parts of sulphur, 2 parts of copper and orpiment each, 1 part of tin and 3 parts of stibium. Now roast them in a closed crucible.²

[Here as well as in the preceding sloka, we have distinct mention of *बन्धमूषा* or a *crucible with the lid on*. This is one of the preparations which can be brought into line with those of the Tāntric and Iatro-chemical periods.]

PREPARATION OF ALKALI AND CAUSTIC ALKALI³

[As Vāgbhaṭa borrows his method of preparation of alkali almost word for word from Susruta, it is quite superfluous to reproduce it here.]

(1) Uttarasthānam, Ch. XIII, p. 20-21.

(2) Ibid, Ch. XIII, p. 31-32.

(3) Sūtra., Ch. XXX.

USE OF MERCURY

Take equal parts of mercury and lead and make them up into a collyrium with their equal weight of stibium and camphor.¹ [This is perhaps the only instance in which the mention of mercury is found.]

(1) "Uttarasthānam," Ch. XIII, 36. This very formula, with but slight variations, occurs also in Rasaratnasamuchchaya, Ch. xxiii, 46.

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The Transitional Period

(From 800 A.D. to circa 1100 A.D.)

**Chemistry in the Siddha Yoga of Vrinda
and in Chakrapani**

CHAPTER I

VRINDA

(Circa 900 A. D.)

PREPARATIONS IN WHICH SULPHIDE OF COPPER
AND

ÆTHIOPS MINERAL FIGURE

Sulphur, copper and the pyrites are to be pounded together with mercury and subjected to roasting in a closed crucible and the product thus obtained to be administered with honey. This is known as “parpati tāmram.”

(1) This preparation does not occur in the Poona edition, but is to be found in the Kāśmīr Ms. under रसायनाधिकारः,

Take one part of sulphur and half its weight of mercury [The components to be rubbed together.]The same to be administered with honey and clarified butter. This is called "rasāmṛita chūrnam."¹

Quicksilver, rubbed with the juice of *dhatūra* s. or *piper betle*, and applied externally, kills lice. (Poona ed. p. 122.)

A COLLYRIUM

Compounded of 14 ingredients amongst which occur the belleric myrobalans, rock-salt, *killed* copper and blue vitriol—all in the powdered form. (Poona edition, p. 470.)

This very preparation, in identical recension, occurs in Chakrapānī under the name of "Nāg-ārjuna Varti."

A PROCESS OF KILLING IRON

The, text which occurs only in the Kāsmīr Ms. under रसायनाधिकारः, unfortunately in a mutilated form, would seem to indicate that the iron is

(1) *Vide* Kāsmīr Ms. under रसायनाधिकारः, omitted in the Poona edition.

to be first ignited in the fire and then macerated in the juice of the emblic myrobalan, and *trewia nudiflora* and exposed to the sun, and again to be macerated in the juice of certain other plants and then to be rubbed in a mortar.

CHAPTER II

CHAKRAPANI

(Circa 1060 A. D.)

BLACK SULPHIDE OF MERCURY (KAJJALI)

or

Æthiops Mineral

The first process consists in the purification of mercury.

“Quicksilver, rubbed repeatedly in the juice expressed from *sesbania aculeata*, *ricinus communis*, *zingiber* and *solanum nigrum*, becomes purified.”

“Take one part of mercury and one part of sulphur, rub the two together in a mortar and thus prepare *kajjali* or *rasaparpati*.¹”

(1) Chakrapāni himself claims its discovery or at any rate its introduction : रसपर्वटिका ज्ञाता निबद्धा चक्रपाणिना । Vrinda, however, recommends its use as well.

TAMRAYOGA (LIT. POWDER OF COPPER COMPOUND)

“Take a thin leaf of Nepalese copper and embed it in powdered sulphur. The substances are to be placed inside a saucer-shaped earthen-ware vessel and covered with another. The rims are luted with sugar or powdered rice-paste. The apparatus is heated in a sand-bath for three hours. The copper thus prepared is pounded and administered with other drugs.”

PROCESS OF KILLING IRON

“I shall now describe the science of iron as promulgated by the sage Nāgārjuna.” [A tedious process given with wearisome minutiae of which the substance only is reproduced below.]

A bar of iron is to be rubbed with the levigated powder of the following vegetable products among others : the belleric myrobalans, *clitoria ternatea*, *vitis quadrangularis*, *boharhaavia diffusa* and *verbesina calend*. It is then strongly heated to the fusion point and plunged into the decoction of the myrobalans. The iron is then powdered by being beaten with an iron hammer. The powder

is then digested in the decoction of the myrobalans and roasted repeatedly in a crucible.

MANDŪRA OR RUST OF IRON.

Rust of iron is prescribed in combination with other drugs.

RECIPE FOR A SOAP TO BE USED AS A DEPILATORY.

The ashes of *schrebera swiet.* and *cassia fist.* are to be mixed with lime from burnt shells and lixiviated with the urine of the ass. The lye is then to be boiled with a definite weight of mustard oil.

PREPARATION OF CAUSTIC ALKALI

[Much the same as in the Susruta]

CALX OF SILVER

In a preparation named "yogarāja" योगराज or calx of silver (probably in the shape of sulphide) figures as a component.

The Tantric Period

(From 1000 A. D. to circa 1300 A.D.)

CHAPTER I

Chemistry In Rasarnava

[In Rasārṇava, as in all other Tantras, knowledge is imparted in the shape of a dialogue between Bhairava (Śiva) and his consort Pārvatī.]

EXTRACTS FROM BOOK IV—ON APPARATUS AND THE COLOUR OF FLAMES

Sri Bhairava said :

“The rasas, the uparāṣas (see p. 79), the metals, a piece of cloth, vidam (see p. 72), a pair of bellows, iron implements, stone pestles and mortars, the apparatus known as Koshfī (see p. 69), mouth blow pipe * * cow-dung, substantial wood (as fuel), various kinds of earthen apparatus (*e. g.* crucibles &c.), a pair of tongs and earthen and iron vessels, weights and balances, bamboo and iron

pipes, the fats, the acids, the salts and the alkalies, the poisons—all those are to be collected and chemical operations begun.”

DOLA YANTRAM

As R. R. S.¹ borrows the description of this apparatus *verbatim*, it is unnecessary to repeat it here.²

AN APPARATUS FOR KILLING METALS

“Make two iron crucibles each 12 digits in length, the one with a narrow orifice containing sulphur is inserted into the other holding mercury; below the mercury is placed water [in a separate vessel]. The mercury and the sulphur should be carefully moistened in garlic juice, which has been filtered through a cloth. The apparatus is now lodged in an earthen pot and another placed over it, the rims being luted with cloth previously smeared with earth * * now cow-dung fire is urged. After continuing heating for three days

(1) R. R. S. is the abbreviation for ‘Rasaratnasamuchchaya.’

(2) See Book ix. of R. R. S.

the apparatus is taken out." [This description, in almost identical recension, occurs in R. R. S. under the name of *अरणाशब्दम्*. The language is faulty and the meaning not very clear.]

GARBHA YANTRAM

"I shall now describe the Garbha Yantram for reducing *pistika*¹ to ashes. Make a crucible 4 digits in length, and 3 digits in width, with its mouth rounded. Take 20 parts of salt and one of bdellium and pound them finely, adding water frequently; rub the crucible with this mixture.

* * * * * Make a fire of paddy husks and apply gentle heat. In the course of one to three days the mercury is reduced to ashes." [*Vide* Illustrations.]

EFFICACY OF THE APPARATUS

"For killing and colouring mercury, an apparatus is indeed a power. Without the use of

(1) A cake of mercury and sulphur.

herbs and drugs, mercury can be killed with the aid of an apparatus alone ; hence an expert must not disparage the efficacy of the apparatus."

HAMSAPĀKA YANTRAM

"Take an earthen dish and fill it with sand and place another over it ; apply gentle heat. Now digest in this apparatus [the ingredients] with the five alkalies (cf. pp. 45 and 69), the urines (see p. 30), and the "vida" (see p. 72). This is known as Hamsapāka Yantram by the adepts."

CRUCIBLES

"Earth of black red, yellow and white colour
 * * burnt husks of paddy, soot, earth from
 the ant-hill, well burnt excrements of the goat and
 the horse * * rust of iron" * *
 [varying proportions of the above ingredients are
 used for making crucibles, retorts, &c.]

"There are two kinds of crucibles, *vis.*, open
 and covered (lit. blind) * * * the covered one

(1) R. R. S. has borrowed the descriptions of Garbha Yantram and Hamsapāka Yantram.

resembles the nipple of a cow and is fitted with a lid, which has a raised head.

“For the purification of silver, the crucible is best made of two parts of the ashes of *schrebera swietenoides*, and one part each of brick dust and earth.”¹

COLOUR OF FLAMES

“Copper yields a blue flamethat of the tin is pigeon-coloured ; that of the lead is pale-tinted².....that of the iron is tawny ; that of the “peacock” ore (*sasyaka*) is red.”³

TEST OF A PURE METAL

“A pure metal is that which, when melted in a crucible, does not give off sparks nor bubbles, nor spurts, nor emits any sound, nor shows any lines on the surface, but is tranquil like a gem.”⁴

(1) The porous crucible is of the nature of a “cupel”.

(2) Cf. “Lead compounds impart a pale tint to the non-luminous gas flame.” (Roscoe and Schorlemmer.)

(3) The reading in the Mss. seems to be defective.

(4) Or in modern phraseology shows ‘signs of tranquil fusion.’

KOSHĪ APPARATUS

“For extracting the essence of metals a koshī apparatus [*Vide* Illustrations] is preferred, which is 16 digits in width and 2 cubits in length.”

COLOPHON TO CHAPTER IV.

“Here ends Chapter fourth of Rasārṇava, which treats of apparatus, crucibles and the colour of flames.”

THE ALKALIES

“The three alkalies are the borax, trona (natron) and Yavakshāra (carbonate of potash). The ashes of sesamum, *achyranthes aspera*, *musa sapientum*., *butea frondosa*, *moringa pterygosperma*, *mochika*, (*schrebera swietenoides*), *raphanus sativus*, *zingiber officinale*, *tamarindus indicus* and *ficus relig.*, respectively are regarded as the standard plant ashes (अवजगारः) VII. 12-13

THE MAHARASAS

“Bhairava said :—“mākshika, vimala, silā, chapala, rasaka, sasyakā, darada (p. 78) and sroton-

jana,—these are the eight mahārasas.” [Vide p. 79 and “Explanatory Notes on Minerals.”] VII. 2-3

COPPER FROM THE PYRITIES.

“Mākshika, repeatedly soaked in honey, oil of *ricinus communis*, urine of the cow, clarified butter and the extract of the bulbous root of *musa sapientum*, and heated in a crucible, yields an essence in the shape of copper.” VII. 12-13

“Vimala, digested with alum, green vitriol, borax and the watery liquid expressed from *moringa pter.*, *musa s.*, and finally roasted in a covered crucible in combination with the ashes of *schrebera swiet*, yields an essence in the shape of *chandrārka*¹ (lit. copper of gold-like lustre.)”

Chapala : [See under R. R. S. Bk. ii.] VII. 20-21

BRASS FROM CALAMINE AND COPPER MISTAKEN FOR GOLD.

“Rasaka : There are three, kinds of it ; namely of yellow colour, of the appearance of treacle, and

(1) R. R. S. has borrowed this description and added some more characteristics of the mineral, from which it would appear that “Vimala” is also a variety of pyrites. [Vide R. R. S. Bk. ii.]

of the colour of stones. What wonder is it that Rasaka mixed with [certain organic matters] and roasted three times with copper converts the latter into gold?" VII. 31-34

EXTRACTION OF ZINC FROM CALAMINE.

Rasaka, mixed with wool, lac, *T. chebula* and borax and roasted in a covered crucible, yields an essence of the appearance of tin : of this there is no doubt." VII. 37-38

Sasyaka.

VII. 41-44

[These couplets have been borrowed word for word by R. R. S. *Vide* Bk. ii; hence repetition is unnecessary.]

SAURĀSHTRI.

Saurāshtri, alum, distillation of: (See under R. R. S., which has also borrowed this description *verbatim*.) VII. 73-74

THE METALS.

"O goddess! listen now to what I say about the metals.

‘Gold, silver, copper, iron, tin and[†] lead’ these are the six metals and their resistance to waste [*i. e.* rusting] is in the order in which they have been mentioned.” VII. 89-90

THE KILLING OF METALS—“VIDA.”

“Hear attentively as I shall now speak of the killing of metals.

“There is no such elephant of a metal which cannot be killed by the lion of a sulphur.” VII. 138-148

Bhairava said : “Kāsisa¹, rock-salt, the pyrites, sauvara², the aggregate of the three spices³, sulphur, saltpetre, the juice expressed from mālati⁴—all these moistened with the juice of the root of *moringa pter.*, makes a vīda, which would kill all [the metals].” IX. 2-3

“Sulphur, orpiment, sea-salt, salt, sal-ammoniac, borax—these digested with the ashes and the urines, give rise to another kind of vīda.” * * *

* * * Having thus collected the ingredients, O goddess ! begin the chemical operations. I have told you all what more do you want to hear ?” IX. 4-20

(1) Green vitriol. (2) Stibnite. (3) namely, black pepper, long pepper and dry ginger. (4) *Echites caryophyllata*, Rox.

PURIFICATION OF QUICKSILVER.

"Quicksilver rubbed with the juice of the aforesaid plants (*vide* original text) and distilled seven times, becomes pure."

"Quicksilver, made into a paste by being rubbed with copper and subjected to distillation, leaves behind tin and lead [with which they are often adulterated] and becomes pure." X. 55-56

KILLING OF MERCURY.

"Green-vitriol, alum, salt, borax, mixed with the aforesaid vegetable drugs, (*vide* original text), kill mercury in an instant [in the shape of calomel.]" XI. 24

KILLING OF GOLD

"Salt-petre, green vitriol, sea-salt, rock-salt mustard, borax, salammoniac, camphor, the pyrites—all these are to be taken in equal parts. The crucible is to be smeared with the milky juice of *euphorbia neriifolia* and *asclepias gigantea*; then, having added the powder of the aforesaid "*vida*," the gold is to be killed, my beloved!"

XI. 83-84

TESTS FOR KILLED MERCURY

"When the mercury assumes divers colours after having given up its fluidity, it is known as swooned; killed mercury is that which does not show signs of fluidity, mobility and lustre."

XI. 197-198

COLOURING OF METALS

"Iron, lead, and copper are coloured by means of calamine—the whole turns into gold." (Cf. VII. 31-34.)

XII. 50

"Mercury is composed of the five elements and represents Siva himself."

II. 78

"Take one pala of the ash of mercury and rub it with the same weight of sulphur and roast the mixture in a covered crucible: thus we get vermilion of the colour of the rising sun."

XVI. 81

"Take the vitriol which is of the colour of the throat of the peacock, saffron, calamine, as also the excrement of a young calf, the poisons, powdered *plumbago seylanica*, all in equal proportions, rub them with the acids and dry in the shade. Having added honey to the above mixture,

smear it on a thin sheet of lead. When roasted in a covered crucible, the lead is coloured in no time ; the lead which is now of beautiful colour is fit for bedecking the persons of the gods."¹ XVIII. 70-74

(1) Refers probably to the "gold-like alloy used by watch-makers" into the composition of which copper, zinc and lead enter. See Roscoe and Schor., 11. p. 494, ed. 1897.

The Iatro-Chemical Period

(From 1300 A. D. to circa 1550 A. D.)

CHAPTER I

Chemistry In Rasaratnasamuchchaya

BOOK I

Salutation to him—the excellent, the greatest physician of the world, by the nectareous ocean, of whose benign glance, resplendent with brilliance, born of everything that is joyous and auspicious and which acts like unfailing elixir, the diseases of his devotees, such as birth, death, old age and worldly attachment, are cured in an instant.¹ I

(1) The salutation is strictly Buddhistic and is on all fours with the opening lines of Vāgbhaṭa's *Ashtāṅgarhṛdaya* and of *Amarakośha*, both of which are known to be by Buddhist authors; cf. also *Lalitavistara* :

वेद्यः सर्वस्य लोकस्य वन्देऽहमपि त्वां विभो । VII. p. 123, R. L. Mitra's ed

जरात्राधिकलिष्टानां प्रादुर्भूतो क्षिप्रग्वरः । xii, p. 150.

Ādima,¹ Chandrasena, Lankesa, Bisārada, Kapāli, Matta, Māndavya, Bhāskara, Sūrasenaka, Ratnakosa, Sambhu, Sāttvika, Naravāhana, Indrada. Gomukha, Kambali, Vyāḍi, Nāgārjuna, Surānanda, Nāgabodhi, Yasodhana, Khandā, Kāpālika, Brahmā, Govinda, Lampaka and Hari—these are the twenty seven experts on Alchemy as also Rasāmkusa, Bhairava, Nandī, Svachchhanda-bhairava, Manthānabhairava, Kākachandīśvara, Vāsudeva, Rishyasringa, the compiler of alchemy, the ascetic Rasendratilaka, Bhāluki, who has got the appellation of Maithili, Mahādeva, Narendra, Ratnākara and Harīśvara. 2-7

This treatise on well-tried mercurials and minerals, named “Rasaratnasamuchchaya,” adapted to the treatment of diseases, is being compiled by the son of Simhagupta, after having consulted the works of the aforesaid adepts and others. It will treat of mercury, the minerals and the metals, the construction of the apparatus, the mystical formulæ for the purification of the metals, the extraction of the essences (active principles), liquefaction and incineration. 8-10

[Here follows a description of the virtues of mercury and its mythical origin.]

(1) The Benares Ms. reads Āgama.

By partaking of mercury, men are freed from a multitude of diseases, arising out of the sins of former existence—of this there is no doubt. 26

He who falls foul of mercury, which is the generative principle of Siva, will rot in the hell *æon* after *æon*. 29

From the mouth of the God of fire * * mercury dropped into the country of Darada¹ and it has there remained ever so long. The soil of that region, on being subjected to distillation, yields mercury. 89-90

COLOPHON

Here ends Book first of Rasaratnasamuchchaya, composed by Vāgbhaṭa, son of Simhagupta, Prince of Physicians.

(1) Dardistan, the mountainous region about Kásmír, is famous for the ores of cinnabar from which mercury is extracted. Darada is in fact a name of cinnabar. The auriferous region of the Daradas is mentioned by Humboldt (Kosmos 11. p. 513 E. C. Otte) who places it either in the Thibetan highlands east of the Bolor chain, west of Iskardo, or towards the desert of Gobi described also as auriferous by Hiouen Thsang. Regarding Párada and Darada see also Lassen's Alterthumskunde, 1. pp. 848-49. It seems probable that "párada" (quicksilver) and "darada" (cinnabar) owe their names to the countries from which their supply was obtained.

BOOK II

THE RASAS.

[In the Hindu Materia Medica the mineral kingdom is broadly divided into the Rasas and the Uparasas, the Ratnās (gems) and the Lohas (metals). The term Rasa is in general reserved for mercury, though it is equally applicable to a mineral or a metallic salt. In the oldest medical works, *e. g.* the Charaka and the Susruta, Rasa has the literal meaning of juice or fluid of the body, which according to the notions of humoral pathology engenders blood, serum, sweat, &c., (see p. 42). Rasakriyā¹ in the Susruta means fluid extract or concentrated decoction. As mercurial and metallic preparations gradually came into vogue and even began to supplant the vegetable drugs, the term *rasa* began to be substituted for quicksilver on account of its semi-fluid character and its supposed miraculous therapeutical action on the juices or humours of the body (Cf. *Rig-Veda*, "Somarasa": *Vide* Intro.) In the Bāvaprakāsa we

(1) साससारदिसारेषु पटोन्नविफलासु च

रसक्रिया विधातव्या शोधनो शोधनेषु च । Sūtra. Chap.

xxxvi, 19.

find *rasa* used in a two-fold sense,—ancient and comparatively modern.¹

In the older works *Rasāyana* (derived from *rasa*, juice, and *ayana*, way) means a medicine preventing old age and prolonging life—the *Elixir vitæ*.² Later on *Rasāyana* was almost exclusively applied to the employment of mercury and other metals in medicine and at present it means also alchemy (chemistry). Our author uses the term

(1) सम्यक् पक्वस्य भक्तस्य सारो निगदिता रसः ।

स तु द्रवः सितः शीतः स्वादुः सिग्धश्च लोभवेत् ॥ Vol. I, p. 59. ed. Kālisa Chandra Sen Gupta.

In the above sloka, *rasa* is used in the sense of *chyle*. Again :—

रसायनार्थिभिर्लोकैः पारदो रस्येव दत्तः ।

ततो रम इति प्राक्तः स च धातुरपि स्रुतः ॥ *ibid.* p. 442.

Here "*rasa*" is used as a synonym of mercury and regarded as a *metal*.

(3) For the definition of the term *Rasāyana* in the *Charaka*, see p. 32; cf. also "रसायनञ्च तज्ज्ञानं यस्मिन् रात्र्यार्धावनाशनम्" Sarnagadhara. Cf. also : "Dies Wort (*rasa*) nämlich hat nicht nur der *rasagnāna*, d. i. Kenntniss der Säfte, einem Kapitel der Medicin, sondern einer Benennung der Alchemie, *rasasāstra*, dann *rasasiddhi*, durch Quecksilber erlangte Vollkommenheit, das Vertrautsein mit der Alchemie, sowie desgl. *rasendradarsana* (wortl. Untersuchung des Säfte-Herrschers d. i. Quecksilbers), Lehre der Alchemisten (dieser heisst *Rasāyana*) seinen Namen geliehen und ausserdem in Compositen einer Menge chemischer Substanzen."—Pott : "Chemie oder Chymie ?" "Zeit. deut. Morg. Ges." xxx, 7

"Rasasiddhipradāyaka" (1-5), which is derived from rasa, mercury, siddhi, accomplishment and pradāyaka, giver or bestower, *i.e.* lit. giver of accomplishment in mercury *i.e.* an expert on alchemy. Wilson in his Dictionary thus happily renders Rasasiddhi: "The knowledge of alchemy, the possession of peculiar familiarity with mercury obtained by the performance of chemical operations conjoined with certain mystical and magical rites and the securing thence to the adept of happiness, health and wealth; the power of transmuting metals and the art of prolonging life."

With these prefatory remarks, we shall now allow our author to proceed.]

Abhra (mica), Vaikrānta, Mākshika (pyrites), Vimala, Adrija (bitumen), Sasyaka, Chapala, and Rasaka: these 8 rasas are to be identified and collected. ¹ [*Vide* "Explanatory Notes on the Minerals" at the end of Chap. I]¹

ABHRA

There are three varieties of mica, namely,

(1) Rasārṇava (p. 69) recognises the following eight minerals:—mākshika, vimala, adrija, chapala, rasaka, darada (cinnabar) and srotonjana (stibium).

pinākam, nāgamandūkam and vajram and each of these again are of four different colours—white, red, yellow and black. 5-10

Mica, the layers of which can be easily detached, is preferred. Mica, which is as bright as the moon and which has the lustre of the rust of iron, does not take up or combine with (lit. swallow) mercury. That which has taken up mercury can alone be used with the metals and administered in medicine. Mica, which has been *killed*, is prescribed in the treatment of various diseases. The variety which has the lustre of the moon, if taken internally, brings on dyspepsia and urinary disorders. 12-14

Mica, heated seven times and plunged into sour gruel or cow's urine or decoction of the chebulic myrobalans or cow's milk, is freed from all impurities. 17-18

Mica, mixed with paddy grains and reduced to powder, tied in a piece of cloth and suspended in sour gruel and then passed through linen, is known as Dhānyabhram (lit. mica in combination with paddy). Dhānyabhram, rubbed with the juice of *cassia sophora* and roasted ten times in a closed crucible, is *killed* thereby. 24

VAIKRANTA

Vaikrānta has eight faces and six angles, is slippery and heavy and of uniform or mixed tint. It has 8 different colours, *viz.*, white, red, yellow blue, with the shades met with in the down of the pigeon, grass-green, black and variegated 55-56

Vaikrānta is a powerful tonic and reckoned among the sovereign medicines. It is a destroyer of all (bodily) disorders and is employed in the place of diamond. 57-58

Vaikrānta is purified by being heated three days with the salts and the alkalies or by digestion with the acids, urines or a decoction of *dolichos uniflorus* and the plantain or of *paspalum scrobiculatum*. It is killed by being roasted in a covered crucible eight times in combination with sulphur and lemon juice and *pasp. scrobi*. 67-68

Vaikrānta, after being heated and plunged into the urine of the horse, ought to be repeatedly roasted and then reduced to ashes. 69

Vaikrānta after incineration is substituted for diamond. 70

Macerated in the ashes of *schrebera swiet. butea frondosa* and cow's urine and mixed with the powdered root of *euphorb. antiq.*, turmeric . . .

borax, powdered lac and made into balls with the milky juice of *asclepias gem.*, and honey and strongly heated in a closed crucible, vaikrānta yields its essence. Of this there is no doubt.

71-72

COPPER PYRITES

Mākshikam (pyrities) is born of mountains yielding gold . . . and is produced in the bed of the river Tāpī and in the lands of the Kirātās, the Chinese and the Yavanas.

77

Pyrites is of two kinds—golden and silvery: the former is a native of Kanouj and is of golden yellow colour. The silvery pyrites is associated with stones and is of inferior quality.

81

Rubbed with the juice of lemons and sulphur and roasted in a closed crucible it is *killed*.

84

Mākshika, repeatedly steeped in honey, oil of the seeds of *ricinus communis*, urine of the cow, clarified butter and the extract of the bulbous root of *musa sapientum* and gently roasted in a crucible, yields an essence in the shape of copper.

89-90

VIMALA

Vimala is described as of three kinds according as it has the lustre of gold, silver and brass respectively.

96

It is rounded and is also endowed with angles and faces. 97

It is killed by being roasted ten times with sulphur, bitumen, *artocarpus lakoocha* and the acids. 100

Vimala, rubbed with borax, the juice of *artocarpus lakoocha* and the ash of *schrebera swiet.*, and roasted in a covered crucible, yields an essence of the appearance of gold. ¹ 101

Vimala digested with alum, green vitriol, borax and the watery liquid expressed from *moringa pter.*, *musā s.* and finally roasted in a covered crucible in combination with the ashes of *schrebera swiet.*, yields an essence in the shape of chandrārka (lit. copper of gold-like lustre). 103-104

SILAJATU

Silajatu (bitumen) is of two kinds, one having the smell of cow's urine, the other resembling camphor. It oozes out in the heat of the sun at the foot of the Himālayas from the bowels of gold, silver and copper respectively. ² (cf. *ante* p. 46) 106

(1) The text reads : : भामसज्जितम् = *lead-like*, which however conveys no adequate meaning. A variant is सौतसज्जितम् = *gold-like*.

(2) The resins of the styrax benzoicum and also a variety of bitumen, especially the latter are referred to. The description is evidently borrowed from the Charaka and the Susruta.

SASYAKA

Sasyaka (blue vitriol) . . . has the play of colour in the throat of the peacock (*i.e.* has blue tint). Mayuratuttham is an emetic, an antidote to poisons and a destroyer of the whiteness of the skin. 127-129

It is killed by being roasted in a covered crucible with the juice of *artocarpus lakoocha*, sulphur, bitumen and borax, 132

EXTRACTION OF COPPER

Take blue vitriol and one-fourth its weight of borax and soak the mixture in the oil expressed from the seeds of *pongamia glabra* for one day only and then place it in a covered crucible and heat in the charcoal fire—by this process an essence is obtained from it of the beautiful appearance of coccinella insect.¹ 133-134

Or, enclosed in a crucible with borax and the juice of lemons and strongly heated, it yields an essence in the shape of copper. 135

Pure blue vitriol, of the colour of peacock, in

(1) *i. e.* red; in the Charka, blood is described as having the colour of the *coccinella* insect. Couplets 133 and 134 have been borrowed almost *verbatim* from Rasārṇava.

combination with the aforesaid drugs and by the application of various processes, gives up its essence. 136

CHAPALA

There are four varieties of Chapala—yellow, white, red and black. That which has the lustre of gold or silver is most appropriate for the fixation of mercury. The last two are indifferent and readily melt like lac and are useless. Chapala melts like tin when heated over fire—hence the name. 143-144

Chapala has six faces and the lustre of a crystal. ¹ 146

RASAKA

Rasaka(calamine) is of two kinds : the one of laminated structure is known as dardura ; the other, non-laminated, is called karavellaka. 149

Calamine is to be heated and plunged seven times into the juice expressed from the seeds of lemon or immersed in the urine of man or of horse or in sour gruel or sour milk and thus purified. 154-155

(1) It is not clear what substance is really meant by the term Chapala ; its radical meaning is mobile or fickle, hence it is a name often given to quicksilver.

EXTRACTION OF ZINC

Rub calamine with turmeric, the chebulic myrobalans, resin, the salts, soot, borax and one fourth its weight of *semicarpus anacardium*, and the acid juices. Smear the inside of a tubulated crucible with the above mixture and dry it in the sun and close its mouth with another inverted over it, and apply heat. When the flame issuing from the molten calamine changes from blue to white, the crucible is caught hold of by means of a pair of tongs and its mouth held downwards and it is thrown on the ground, care being taken not to break its tubulure.¹ The essence possessing the lustre of tin which is dropped is collected for use.

157-161

Calamine is be powdered with lac, treacle, white mustard, the myrobalans, natron and borax and the mixture boiled with milk and clarified butter and made into balls. These are to be enclosed in a crucible and strongly heated. The contents are then poured on a slab of stone—the essence of calamine of the beautiful appearance of tin (thus obtained) is to be used.

163-164

(1) The Benares Ms. reads “ग्रथा नाल मज्जन” and drops न which would mean so “as to break its tubulure.”

Or a vessel filled with water is to be placed inside a *koṣṭhī* apparatus and a perforated cup or saucer placed over it; a crucible charged as above is to be fixed in an inverted position over the saucer and strongly heated by means of the fire of jujube (*sīzyphus iujuba*) charcoal: the essence which drops into the water should be applied (in medicine). [*vide* illustrations] 165-166

This essence is to be mixed with orpiment and thrown over an earthen dish and rubbed with an iron rod till it is reduced to ashes. [From the context it is evident that the operation is to be performed over fire.] 167-168.

BOOK III.

THE UPARASAS OR INFERIOR RASAS

Sulphur, red ochre, vitriol, alum, orpiment, realgar, anjana and *kamkushṭha*—these are the eight uparasas, useful in operations of mercury. 1

[Here follows the mythical origin of sulphur.]

SULPHUR

Sulphur is of three kinds: that of the first quality resembles the beak of a parrot; that of the second quality is yellow; whereas the white variety is the worst. Another authority says: there are four kinds of sulphur according as it is of white, yellow, red and black colour respectively. ..the black variety is rare.¹

12-15

Melted sulphur is poured into the juice of *verbesina calendulacea* and thus purified.

A vessel which contains milk has its mouth tied down with a piece of cloth, over which is deposited finely powdered sulphur; the latter again covered with an earthen bowl. Heat is applied from above by burning cow-dung cakes. The melted sulphur drops into the milk and is thus purified.

24-25

GAIRIKA

Gairika (red ochre) is of two kinds: the one, *pāshāṇa gairika*, is hard and copper-coloured; the other is *svarna gairika i. e.* of the colour of gold (yellow).

46

(1) Cf .."il y a des soufres des diverses couleurs; l'un rouge, l'autre jaune un autre blanc pariel á l'ivoire;...un autre, noir, qui ne vaut rien." "La Chimie au moyen âge," 1, 307.

KĀSISA

Kāsisā (sulphate of iron) is of two kinds: vālukā-kāsisā and pushpa-kāsisā. [The former termed in other works dhātukāsīsa is the green variety and the latter, the *basic* or yellowish variety.] 51

Its essence is to be extracted like that of alum.

54

TUVARĪ

Tuvarī (alum): the fragrant earth produced in the mountains of Surat is known as tuvarī, which dyes cloth and fixes the colour of madder. ¹ 59

A second variety of it called phatakī or phullikā is slightly yellow . . . Another variety known as phulla tuvarī is white and acid in taste; iron changes to copper by the process of *lepa* [cf. Bk. VIII, 80, where the term “*रूपः*” is used in the sense of transmutation of the baser metals. The author seems to convey the idea that alum plays an important part in this process.] 60-62

Alum is astringent, acid, beneficial to the eye... and *killer* of mercury.²

(1) *i.e.* forms lakes.

(2) *अमृतमर्त्य*; Cf. the various formulæ for the preparation of calomel in which alum yields sulphuric acid and plays an important part.

Alum is to be macerated in the bile of the ox one-hundred times and then its essence is to be extracted by distillation¹—a very secret process, not to be divulged. 65.

TALAKA

Tālaka (orpiment) is of two kinds: the one is of a leafy structure, the other is found in balls or cakes and is of golden colour . . . and bright. 66

It is purified by being digested in the juice of cucumber and the alkaline water of the ashes of sesamum or in lime water. 69

Tālaka is to be rubbed with buffalo's urine and thrice macerated in the decoction of *butea frondosa* of the consistency of honey, and then to be roasted in a covered crucible and powdered. This operation is to be repeated twelve times. It is then fit to be used in medicines.* 74-75.

Take one pala of tālaka and rub it for one day with the milky juice of *calopropis gigantea* and mix

(1) पातयेत् सत्वम् ; here distillation is expressly mentioned. Couplet 65 is borrowed from Rasārṇava.

(2) Most likely a sulpharsenite of potash is formed. The process in Rasendrasārasamgraha is more scientific. "Tālaka is to be cut into small pieces and rubbed with lime water and the alkaline water derived from the ash of *achyranthes aspera* and is then to be enclosed in carbonate of potash and roasted."

it with the same weight of oil and heat it in an open place for 7 days and nights together. Collect the white essence when it has cooled down.¹ 80-81

MANASSILA

Manassila (realgar) is mixed with one-eighth part of its weight of iron-rust, molasses, bdellium and clarified butter and enclosed in the *koshṭi* apparatus [see p. 69] and strongly heated, when it yields its essence. 95

THE ANJANAS

The Anjanas (collyriums): of these there are Sauvirānjana, Rasānjana, Srotonjana, Pushpānjana, and Nīlānjana; their properties are described below.

97-98

Nīlānjana is a *killer* of gold [cf. the *killing* of gold, silver, iron and copper in Vāgbhata, p. 55] and induces softness in iron, *i.e.* renders it easily pulverizable [as the iron becomes impregnated with the brittle sulphide of iron; cf also Bk. viii, 38.]

104

The essence of the anjanas is to be extracted like that of realgar.

(1) It is evident that the operation is to be performed in a glass retort or in the *koshṭi* apparatus described below under realgar.

[We quote below the account given in Dutt's "Materia Medica of the Hindus" as our author gives rather scanty information on this point :

"Galena or sulphide of lead is called anjana or sauvīrānjana in Sanskrit, and krishna surma in vernacular. It is called anjana which literally means collyrium or medicine for the eyes, from the circumstance of its being considered the best application or cosmetic for them. The other varieties of anjana mentioned are Srotonjāna, Pushpānjana and Rāsānjana.

"Sauvīrānjana (सौवीराञ्जन) is said to be obtained from the mountains of Sauvira, a country along the Indus, whence it derives its name. The article supplied under its vernacular name surma is the sulphide of lead ore. Sauvira is usually translated as sulphide of antimony, but I have not been able to obtain a single specimen of the antimonial ore from the shops of Calcutta and of some other towns. The sulphide of antimony occurs in fine, streaky, fibrous, crystalline, masses of a radiated texture: The lead ore on the contrary occurs in cubic masses destitute of rays and is tabular in its crystalline arrangement.

"Srotonjana (श्रोतोञ्जन) is described as of white colour, and is said to be produced in the bed

of the Yamunā and other rivers. It is called Saffed Surma in the vernacular, and the article supplied under this name by Hindustani medicine-vendors is calcareous Iceland spar.¹ It is used as a collyrium for the eyes, but is considered inferior to the black surma or galena.

“Pushpānjana (पुष्पाञ्जन) is described as an alkaline substance. I have not met with any vernacular translation of this word nor with any person who could identify or supply the drug. Wilson, in his Sanskrit-English Dictionary, translates the term as calx of brass, but I know not on what authority.

“Rasānjana (रसाञ्जन) is the extract of the wood of *berberis Asiatica* called *rasot* in the vernacular.”]

Kāmkushtham is produced at the foot of the Himalayas . . . Some are of opinion that it is the excrement of a new-born elephant . . . it is of white and yellow colour and is a strong purgative.²

109-112

(1) See, however, *ante* p. 55.

(2) Not well made out. According to Wilson, it is a medicinal earth, described as of two colours, one of a silvery and the other of a gold colour.

THE COMMON RASAS

Kampilla, Chapala¹ Gauripāshāna, Navasāra-ka, Kaparda, Agnijāra, Hingula, Girisindūra, Mrid-dārasringakam : these are the eight common Rasas regarded as useful adjuncts to chemical operations by Nāgārjuna and other experts. 120-121

Kampilla² is like brick-dust . . . a purgative . . . natural product of Surat . . . and a vermifuge.

Gauripāshāna¹ is of the lustre of rock-crystal, conch and turmeric respectively . . . its white essence is to be extracted like that of orpiment.

124-125

NAVASARA AND OTHER RASAS

Navasāra (sal ammoniac) is begot of the decomposition of the shoots of bamboos and of the wood of *careya arborea* ; navasāra is an alkali, its another name is *chulikālavana* (lit. salt deposited in

(1) Including Chapala there are nine common Rasas ; but Chapala has already been considered as a mahārāsa. (see p. 87)

(2) The red mealy powder covering the capsules of *mallotus Phillippensis*, also known as kamalā. It is not clear why this substance should have found a place among the products of the mineral kingdom.

(3) Not easy to identify ; lit., it means white stone or marble.

the hearth), it is produced during the burning of the brick . . . it kills mercury, liquefies iron, is a stomachic, an absorbent of the spleen, and aids digestion after much eating.¹ 127-129

Varātaka (cowrie or marine shell): alchemists prefer shells which are of yellow colour, knotty and possessed of circular lines on the dorsal side

macerated for three hours in sour gruel, it undergoes purifications.² 130-134

Agnijāra is a substance discharged from the

(1) It is of interest to note that Royle, who wrote in 1837, regrets that "no Hindu work on this subject (chemistry) has yet been translated" and is bold enough to predict that "Sal ammoniac must have been familiar to the Hindus, ever since they have burnt bricks, as they now do, with the manure of animals as some may usually be found crystallized at the unburnt extremity of the kiln."—"Antiquity of Hindu Medicine." Royle's surmises have proved to be literally correct. The word "Navasāra" is apparently of Persian origin being corrupted from "*Nausadar*."

(2) The text is almost exactly the same as in "*Rasendrasārasaṅgraha*," which gives an additional method of purifying the cowrie, namely:—"Dig a hole in the ground and fill it partly with the husk of paddy, now place on it a crucible containing cowries; cover it with cow-dung cakes and set fire to the mass. By this process the cowries are reduced to ashes." It is the lime thus obtained, which is often used in medicine.

womb of a kind of sea-crocodile and dried in the sun.¹ 135

Gīṛiṣindūra (lit. vermillion, derived from the rocks) occurs among the big mountains (inside the rocks). 137

Hingula (cinnabar : Syn. darada, see p.78) ; quicksilver extracted from it is as efficacious as killed sulphur. When darada is placed in a retort and its essence collected in water, it yields the same substance as quicksilver—of this there is no doubt. (The apparatus referred to is shown in the illustrations). 141-144

Mṛiddarasringakam [various readings of the text are given; it is not easy to make out what substance is meant]. It is yellow and of leafy structure and occurs in Gujārat and round about mount Abu. 145

Rājāvarta (Lapis lazuli) has a bluish tint but with slight admixture of red.....it is killed by being powdered in combination with lemon juice and sulphur and roasted 7 times in a covered crucible. 149-153

(1) Not identified. Perhaps the origin is mythical. गज is a crocodile, but as is well-known this Saurian never flourishes in the sea. According to राज निचय, agnijāra is a marine medicinal plant.

BOOK IV

THE GEMS

The gems also are regarded as the agencies, which help the fixation or coagulation of mercury. These are the gems: *Vaikrānta*, *Suryakānta* (sun-stone), *Hīrakam* (diamond); *Mauktikam* (pearls), *Chandrakānta* (moon-stone), *Rājāvarta* (lapis lazuli) and *Garuḍodgara*, the emerald (lit. derived from the vomit of *Garuḍa*); the topaz, the sapphire, the coral, the cat's eye are also reckoned among the gems. These are to be carefully collected for the fixation of mercury.¹

(1) The ruby and the zircon are also mentioned. The *Vaikrānta* "is a kind of gem said to resemble a diamond, and to be of similar properties." Wilson. *Suryakānta* and *Chandrakānta* are gems of fabulous existence, supposed to be formed by the congelation of the rays of the sun and moon respectively. They may also refer to some sort of crystals. The description of the gems, other than diamond, is meagre and vague. The following extracts from *Manimāla* or "A Treatise on Gems" by Sir Raja Saurindra Mohan Tagore, Mus. Doc., will, to a certain extent, make up for the deficiencies.

"Mention is made of gems and jewels in the earliest writings of the Hindus. The Vedas speak of a place illuminated by rubies and diamonds, which gave out a light as refulgent as that of the planets. Precious stones play a prominent part in the mythologies

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### VAJRAM

Vajram (diamond) is of three kinds: male, female and hermaphrodite, and its medicinal properties vary in excellence in the order in which they have been spoken. 26

The one with 8 angles and 8 faces and 6 corners, very brilliant, with the play of rainbow-colours<sup>1</sup> is known as the male diamond, whereas the female diamond is flattened and rounded whilst the neuter is rounded, obtuse-angled and slightly heavy: 27-28

Each of these again is divided into 4 classes according to its colour namely: Brāhmaṇa, Kshatriya, Vaisya and Sūdra.<sup>2</sup> 30

of the Hindus, in their traditions, poems and legends. In the two great epics of Hindustan, the Rāmāyaṇa and the Mahābhārata, frequent mention is made of stones and pearls with which the kings and the people of the period used to decorate their person."

(1) The high refractive and dispersive power of diamond is evidently referred to.

(2) "Diamonds white like the conch, waterlily, or crystal are Brāhmaṇas; those which are red like the eyes of the hare are Kshatriyas; those which are verdant like the cool plantain-leaf are Vaisyas; those which resemble in colour the clean sword, are known as Sudras." Manimāla, 1.100.

Diamond is a bestower of long life, a tonic, an allayer of the three derangements [namely, of air phlegm and bile], a killer of all the ailments, a fixer of mercury, a subduer of death—in short it is like nectar.

Diamond is digested in the decoction of kulattha (*dolichos uniflorus*) or of kodrava (*paspulum scrobiculatum*) for three hours and thus purified. Diamond is to be macerated four times in the blood of the bug and enclosed in a ball made of the flesh of the musk-rat and then to be roasted in a covered crucible 30 times or to be heated 100 times and plunged in the decoction of kulattha. 34-37

Diamond is to be placed in a covered crucible, the inside of which has been coated with realgar, rubbed with the decoction of kulattha and the juice of *artocarpus lakoocha* and roasted 8 times in succession in the fire of dry cow-dung cakes. It is then heated 100 times and thrown into pure mercury—the diamond is thus killed and reduced to fine ashes. 38-39

The veracious alchemist Somasenānī, after having convinced himself of the success of this process by his own experiments, has given it to the world.

40

Diamond is to be 7 times smeared in the blood

of the bug and dried in the sun and then to be placed in an iron pot and filled with the juice of *cassia sophora* and heated 7 times. The diamond is sure to be reduced to ashes. This process has been described by the sage Brahmajyoti. 41-42

Diamond smeared with the powder of lead, levigated in the juice of the fruit of madana (*randia dumetorum*), and roasted 20 times in a covered crucible; is reduced to fine powder; which is to be used in medicines.<sup>1</sup>

#### GENERAL PROCESS OF REDUCING GEMS TO ASHES

All the gems with the exception of diamond are killed when roasted eight times with a mixture of realgar, sulphur and orpiment, rubbed in the juice of *artocarpus lakoocha*. 63

Take asafoetida, the five salts, the three alkalies, *rumex vesicarius*; sal ammoniac, the ripe fruit of the croton plant; jālāmukhi (*anthericum tuberosum*), rudanti (*asclepias rosea*), the root of *plumbago zeylanica*, and the milky juice of *euphorbia antiquorum* and *calotropis gigantea*—rub all

(1) One or two processes not mentioned by our author may be quoted from "Rasendrachintāmaṇi":—

these together and make them into a ball. Place inside it the noble and luck-yielding gems. Wrap the ball with the leaves of *betula bhojpattra* and tie them with thread and enclose the ball again in a piece of cloth and suspend it in a *dolāyantra* (see Bk. IX) filled with the acids and sour gruel and apply strong heat for three days and nights—the liquid principle of the gems is thus collected.

64-69

Powdered pearl is to be rubbed with the juice of *rumex vesicarius* and then transferred inside a lemon and stowed in a mass of paddy. At the end of a week it is heated in a crucible and liquefied.<sup>1</sup>

70-71

"Take the root of *piper betle* or of the cotton plant (*Gossypium herbaceum*) three years old, and rub it into a paste and enclose the diamond in it and roast it in a covered crucible seven times, when the diamond will be killed."

"An intelligent person should place in a brass vessel a frog which out of fright will pass water. A diamond is to be heated and plunged into this urine. This process being repeated several times, the diamond is killed." This last recipe is also to be found in Sarngadhara. Couplets (44-45) do not occur in the Benares Ms.

(1) Couplets 70, 71 and 72 do not occur in the Benares Ms

Diamond, placed inside the stem of *vitis quadrangularis*<sup>1</sup> and heated four weeks in acids, is liquefied. 72

Vaikrānta, which is of white colour, liquefies when macerated in the juice of *rumex vesicarius* and exposed to the sun for a week. 73

— Take the juice of *pandanus odoratissimus* rock-salt, svarna pushpikā together with *coccinella* insect. Vaikrānta melts on being digested in this concoction for a week. 74

## BOOK V

### ON METALS<sup>2</sup> ( लोहानि )

The pure metals are : gold, silver, and iron. The putilohas (lit. metals emitting a foetid odour) are two : lead and tin. Dhātuloham is iron proper and often conveys different meanings. The alloys are three in number : brass, bell-metal and vartaloḥa. I

(1) बकुवङ्गौ according to "Vaidyakaśābhasindhu" is the same as बलिचंदारवृक्षा i.e. *vitis quadrangularis*.

(2) Loha (lit. iron) is often used in the wider sense of a metal.

## GOLD

Gold is known to be of five kinds :—of which 3 are attributed to mythical and celestial origin; the fourth is called *kshanija* (lit. begot of mines) : the 5th is obtained by the transmutation of the baser metals. (See Bk. VIII, 80-83.) 2

Gold is to be purified and killed, as otherwise [if taken internally] it robs one of strength, virility and happiness and brings a series of maladies. 11

Gold-leaf of the weight of one *karsha* is to be smeared with salt and placed between two earthen saucers and heated on a charcoal fire for an hour and a half when its true colours will come out. 12

The best method of *killing* all the metals is with the aid of the ashes of mercury.<sup>1</sup> The next best is through the agency of the roots, whereas *killing* with sulphur is least to be recommended. 13

When a metal is *killed* with *ariloha* (meaning: not clear), it is injurious. Gold-leaves, pierced with holes and coated with a paste of lemon juice and the ashes of mercury and roasted ten times are thereby *killed*. 14

Project into melted gold its own weight of the ash of mercury ; [when cooled] powder it and rub

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(1) Generally sulphide of mercury (see p. 65).

it with lemon-juice and cinnabar and roast it in a covered crucible twelve times. The gold thus acquires the colour of saffron.<sup>1</sup> (cf. *Rasārṇava* XVI. 81, p. 74). 15-16

Gold-leaf is killed by being rubbed with one-fourth of its own weight of *killed* mercury and acid of any kind and roasted eight times.<sup>2</sup> 17

### SILVER

Silver is of 3 kinds : namely *sahajam* (of mythical origin), begotten of mines and artificial. 22

Silver melted with lead and borax undergoes purification ..... Arrange on an earthen dish a mixture of lime and ashes in a circular row and place in it silver with its equal weight of lead. Now roast it over fire until the lead is consumed. Silver thus purified is to be used for medicinal purposes.)<sup>3</sup> (Cf. p. 68) 32-34

(1) This refers to the mistaken notion that the sublimate of factitious cinnabar (vermilion) contains gold.

(2) It will be seen that although *killing* with sulphur direct is not recommended, the gold is in reality converted into the sulphide and afterwards into metallic gold in a fine state of powder. See under "Killing of Metals."

(3) Cf. *Rasārṇava* नागेन चारराजिन द्राविंतमुद्दिष्टव्यति। "Silver is purified by being melted with lead and the ashes." The process is practically that of cupellation.

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Silver-leaf is to be rubbed with mercury and the juice of *artocapus lakoocha* and is to be embedded in sulphur and heated in a covered crucible over a sand-bath; when cold, the mass is once more rubbed with orpiment and acids and roasted 12 times. By this process, the silver is reduced to ashes 35-37

Silver is reduced to ashes by being 3 times rubbed with powdered iron pyrites and lemon juice and roasted in a covered crucible. 38

Take 4 parts of silver-leaf and one of orpiment and rub them with the juice of lemon and roast the mixture and repeat the operation 14 times and thus silver is completely incinerated.<sup>1</sup> 40-41

### COPPER

There are two varieties of copper: the one brought from Nepal is of superior quality; that dug out of the mines of other countries is designated Mlechchha. 44

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(1) We shall complete the account with an extract from Rasendrasarasamgraha: "Silver-leaf is pierced with holes and smeared with twice its weight of cinnabar and subjected to distillation in the Pátana Yantra (see Bk. IX on apparatus). The mercury comes off and killed silver remains behind."

(2) The generic term for a barbarian or a foreigner.

Copper-leaf is killed by being rubbed with lemon-juice, sulphur and mercury and roasted thrice

55

### IRON

There are three kinds of iron : namely, *mundam* (wrought iron), *tikshnam* and *kāntam*; *mundam* again is of 3 varieties : *viz.*, *mridu*, *kuntham* and *kadāram*.

That which easily melts, does not break and is glossy is *mridu*; that which expands with difficulty when struck with a hammer is known as *kuntham*; that which breaks when struck with a hammer and has a black fracture is *kadāram*. 71-72

*Tikshnam* (properly cast-iron, steel) : there are 6 varieties of it. One variety is rough and free from hair-like lines and has a quicksilver-like fracture and breaks when bent. Another variety breaks with difficulty and presents a sharp edge.

75-78

*Kāntam* : there are 5 kinds of it, namely, *bhrāmaka*, *chumbaka*, *karshaka*, *drāvaka* and *romā-kānta*. It possesses one, two, three, four and five faces and often many faces [with which to attract iron] and is of yellow, black and red colour respectively. The variety which makes all kinds of iron move about is called *bhrāmaka*, that which kisses

iron is called chumbaka, that which attracts iron is called karṣhaka, that which at once melts the iron is called drāvaka (lit. a solvent) and the fifth kind is that which, when broken, shoots forth hair-like filaments. 84-89

Mercury is like an intoxicated elephant and kāntam is like the bent hook wherewith to restrain it. The wise man digs it out of the mines. That which has remained exposed to the sun and the atmosphere is to be avoided.<sup>1</sup> 92-93

If water is kept in a vessel and oil poured over it and the oil does not spread about; if asafoetida gives up its odour and decoction of neem (*Melia azadirachta*) its bitterness and milk, being boiled in it, does not overflow but rises high like a peak—if such be the characteristics of the vessel, know that it is made of kānta iron. 94

Powdered iron is to be macerated awhile in the decoction of the three myrobalans, in cow's urine and then to be mixed up with clarified butter and fried in an earthen vessel and stirred with an iron rod until a blade of straw thrown over it catches fire. The iron powder is to be pounded and the above process repeated five times.

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(1) Couplets 84-93 are taken bodily from *Rasānava*.

Or iron is roasted four times in a covered crucible with the decoction of the myrobalans and is reduced to fine powder.<sup>1</sup> 104-105

Leaves of *tikshṇa* iron are repeatedly to be heated and plunged into water and then to be powdered in a stone mortar with an iron pestle \* \* \* The powder of iron thus obtained is to be roasted twenty times in a covered crucible in combination with mercury and sulphur, and after each roasting the powder of iron is to be pounded as directed above—iron thus reduced to ashes is to be used in medicine. 107-110

Take one part of iron and twentieth part of its weight of cinnabar and rub them with lemon juice and sour gruel and roast the mixture in a covered crucible. The operation being repeated 40 times, *kāntam*, *tikshṇam* and *mundam* are killed—of this there is no doubt. 113-114

Take of mercury one part, sulphur two parts and iron powder three parts and rub them with the juice of the Indian aloe and after 6 hours transfer the mass to a brass-vessel and cover it with the leaves of the castor-oil plant. At the end of an hour and a half the mass will become heated. It is

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(1) The process is practically the same as that of Chakrapāṇi, who ascribes it to Nāgārjuna. (See p. 62.)

then buried under a heap of paddy grains and taken out after three days and then powdered very fine and the contents passed through linen.<sup>1</sup> All the three varieties of iron are thus completely killed. Gold and other metals can be killed by this process after being reduced to fine powder like iron.

134-137

Rust of iron is to be heated and powdered till it is reduced to fine powder—this is called *mandūra*.<sup>2</sup>

147

The qualities which reside in killed iron are also to be found in the rust of iron, hence the latter may be substituted for the treatment of diseases. <sup>3</sup>

148

## TIN

*Vangam* (tin) is of two kinds—*kshurakam* and *misrakam*; the former is endowed with superior qualities; the latter cannot be recommended for medicinal uses.

153

(1) "*Rasendrasārasamgraha*" has the same recipe with slight variations. According to it the powder is so fine that it "floats on water like a duck." Cf. below p. 119.

(2) Analysis of "*Mandūra*"; see Appendix I.

(3) This couplet also occurs in *Rasendrasārasamgraha*.

Kshurakam is white, soft, cool (to the touch), readily fusible and bright and does not clink (when struck). 154

Misrakam is dirty white \* \* \* This is an anthelmintic and a destroyer of the urinary disorders. 155

Molten tin is dropped into the juice of *Negundo vitex* mixed with turmeric; the process being repeated 3 times, the metal undergoes purification. 154-156

Tin foil is to be smeared with a paste of orpiment and the milky juice of *Calotropis gigantea* and then to be covered with the ashes of the bark of *Ficus religiosa* and *Tamarindus Indicus* and roasted and then reduced to ashes.<sup>1</sup>

## LEAD

Sisakam (lead) is readily fusible, very heavy.

(1) A few more recipes are given, in all of which orpiment plays an important part; the one quoted below from Rasendra-sārasamgraha will yield the "ash" of tin in the shape of an oxide. "Melt tin in an earthen pot and to the molten metal add an equal weight of powdered turmeric and Ajowan (*Ptychotis ajowan*) and cumin seeds, and afterwards the ashes of the bark of *Tamarindus Indicus* and *Ficus religiosa* and continue stirring over fire. The tin will be reduced to ashes."

presents a black and bright appearance on fracture, is of foetid odour<sup>1</sup> and black exterior. 171

Take of lead 20 palas and apply strong heat to it and drop into the molten metal one karsa of mercury and throw into it one after another the ashes of *Terminalia arjuna*, *T. bellerica*, pomegranate and *Achyranthes aspera*, weighing one pala each. The mass being vigorously stirred with an iron spoon for 20 nights in succession, the metal is calcined yielding a bright red ash.<sup>2</sup> 176-179

(1) Lead and brass (see below) are said to emit an offensive odour. In connection with this it is interesting to read Professor W. E. Ayrton's address "On the Smell of Metals"—Brit. Assoc. Rep. 1898, p. 772. Cf. also "Alch. Syr." *Trad.*, 121, as well as the opening lines of the present Book describing tin and lead "as metals of foetid odour." In the Syrian Alchemy "Silver is distinguished from tin by its absence of foetid odour"; regarding this M. Berthelot very pointedly remarks: "on voit que l'odeur propre que dégagent les métaux frottés avec la main, ou bien au contact d'une matière organique, jouait un rôle important dans leur étude chez les anciens auteurs; importance que cette odeur a perdue aujourd'hui.—"La Chimie au moyen âge": T. ii. 121 (trad.)

(2) The following process is given both in the "*Rasendra-chintāmaṇi*" and "*Rasendrasārsamgraha*": "Rub lead with the juice of *Adhatoda vasica* and melt it in an earthen pot add to it one fourth its weight of the ashes of *Adhatoda* and *achyranthes aspera* and stir the mass with a rod *Adhatoda vasica* and heat over a fire. Repeat the process seven times. The lead will be turned to vermilion-like powder."

Leaves of lead are to be smeared with a paste of orpiment and the milky juice of *Calotropis gigantea* and roasted in a covered crucible till the metal is entirely killed. 184

#### BRASS, BELL-METAL, &C.

Pittala (brass) is of 2 kinds—ritikā and kākā-tundī; the former on being heated and plunged into sour gruel turns copper-coloured. 192-193

Brass, which is heavy, soft, of yellow colour, capable of resisting strokes, is to be recommended. 195

Brass, which is light and of effensive odour, is not good for medicinal purposes. 196

Brass, smeared with a paste of lemon juice, orpiment and sulphur and roasted 8 times, is reduced to ashes. The process of killing brass is the same as that of copper. 201-202

Kāmsya (bell-metal) is made by melting together 8 parts of copper and 2 parts of tin. 205

It is completely killed by being roasted 5 times with sulphur and orpiment. 210

Vartaloham is produced from Kāmsya, copper, pittala, iron and lead; hence it is regarded by metallurgists as an alloy of 5 metals..... It is killed with the aid of sulphur and orpiment. 212-216

# HINDU CHEMISTRY

## BOOK VI

### INITIATION INTO DISCIPLESHIP

[This chapter is full of directions for the mystic Tāntric rites after the performance of which the pupil is to be initiated into the secrets of mercurial lore.]

The instructor must be wise, experienced, well-versed in chemical processes, devoted to Siva and his consort Pārvatī sober and patient. The pupil should be full of reverence for his teacher, well-behaved, truthful, hard-working, obedient, free from pride and conceit and strong in faith. 3-7

Chemical operations are to be performed under the auspices of a ruler, who is God-fearing, who worships Siva and Pārvatī and whose territory is free from anarchy; and the Laboratory, to be erected in the depth of a forest, should be spacious, furnished with 4 doors and adorned with the portraits of the Gods. 13-15

Take of gold-leaf 3 *niskas* in weight and quick-silver 9 *niskas* and rub them with acids for 3 hours. Make the amalgam into a *phallus* (emblem of Siva, the creative principle).....the *phallus* to be worshipped in due form. By the mere sight

of the *phallus* of mercury, the sins accumulated by the killing of 1,000 Brāhman̄s and 10,000 cows are redeemed. 19-22

The science of mercury was communicated by Siva himself and is to be imparted by the instructor to the disciple according to the prescribed rules with closed eyes. 30

[Here follows an account of certain disgusting and obscene rites borrowed from Rasār̄nava and other Tāntric works.]

The apparatus and implements as also the ingredients required for chemical operations (see next Book) are also to be addressed in prayer

. . . . . and the names of the 27 alchemists to be invoked. [See opening lines : Bk. 1, p. 77.]

53-61

The science of mercury is to be strictly kept a secret . . . . if it is divulged, its efficacy is gone 70

## BOOK VII

### ON THE LABORATORY

The Laboratory is to be erected in a region, which abounds in medicinal herbs and wells . . .

## HINDU CHEMISTRY

. . . it is to be furnished with the various apparatus. The *phallus* of mercury is to be placed in the east, furnaces to be arranged in the south-east, instruments in the south-west ; washing operations in the west ; drying in the north-west. .

. . . . . The *koshī* apparatus for the extraction of essences, the water vessels, a pair of bellows and various other instruments are also to be collected as also the threshing and pounding mortars, the pestles, sieves of various degrees of fineness, earth for the crucibles, charcoal, dried cow-dung cake, retorts made of glass, earth, iron and conch-shells, <sup>1</sup> iron-pans, &c. 1-18

Those who are truthful, free from temptations, given to the worship of Devas and Brāhmanas, self-controlled and used to live upon proper diet and regimen—such are to be engaged in performing chemical operations. 30

Such herbalists as are not deceitful and are well-versed in the knowledge of the drugs and plants and in the language of many countries should be employed. 32

(1) Probably lime crucibles and retorts are meant.

## BOOK VIII

## ON TECHNICAL TERMS

For the comprehension of ignorant physicians, Somadeva<sup>1</sup> is now expounding the technicalities as made use of by experts. 1

The physician is entitled to half the share of prepared mercury and eighth part of medicated oils and *ghee* and seventh part of prepared iron and other metals. 2

Mercury, on being finely rubbed with melted sulphur and other minerals, attains the tint of collyrium and is called *kajjali* (see p. 61), which again on being rubbed with a liquid substance is known as *Rasapanka* (lit. mud of mercury). 5-6

## TESTS FOR KILLED IRON.

*Killed* iron is that which in the shape impalpable powder floats on water and when rubbed between the thumb and the fore-finger enters the lines; which, on being mixed with treacle, *abrus p.*, honey

(1) The author evidently reproduces this chapter from a standard work on the subject by Somadeva. There is a work

and *ghee* and heated, does not revert to the natural state; which floats on water like a duck and does not sink down even when heavy things like paddy grains are placed over it. (Cf. *ante* p. 111, foot-note).

25-28

*Killed* iron (or a general in *killed* metal) is that which on being heated with silver does not mix (or alloy) with it.<sup>1</sup>

29

### ANTIMONY FROM STIBNITE

Nilāñjana,<sup>2</sup> mixed with *tikshnam* (cast iron) and strongly heated several times, yields a superior kind of lead which is readily fusible and is of mild black colour.

38

[Here follows a list of metaphorical expressions which are technically used.]

named Rasendrachūdāmani by Somadeva. We hope to notice it in the second volume.

(1) The Poona ed. has रौप्यं च चेल्लगेत् *mixes with silver*; but the Benares and the Kásmír Mss. read रौप्यं न चेल्लगेत् *does not mix with silver*. The latter is no doubt the correct reading.

(2) Stibnite. A synonym for it is *souvirāñjana*. The "superior kind of lead" is evidently antimony.

## CERTAIN OTHER TECHNICAL TERMS

The resurrection of the dead is known as utthāpana (lit. raising).<sup>1</sup> 39

The capacity of mercury to swallow food [i. e. to combine with certain substances or to take up the qualities inherent in them] is known as grāsa-mānam. 64

Mercury, alloyed with one-sixty-fourth part of its weight of gold or silver, acquires a mouth where-with to swallow even hard metals. 68-69

Lepa, kshepa and kunta signify dhūma i. e. smoke. By the process of lepa is meant the conversion of iron into gold or silver. 80

The conversion of iron into gold or silver with the aid of mercury thrown into a smoky flame, emitting vapour, is known as dhūmavedha (lit. pierced by smoke). 83

The conversion of a small quantity of a metal into gold through the agency of mercury. . . .  
. . . which has acquired a mouth (see sloka 68), is called sabdavedha.<sup>2</sup> 84

(1) *e.g.*, the conversion of *killed* iron into the metallic state.

(2) It is to be regretted that the details of the processes have been withheld. We have here sufficient indication of the belief in the transmutation of metals. The processes here mentioned are probably of the same nature as given in *Rasārnava*.

Somadeva collected these brilliant gems of technical terms with great care from the ocean of mercurial lore and strung them into a necklace which adorns the best of physicians in assemblies.

89

## BOOK IX

### ON APPARATUS THE (YANTRÂS) <sup>1</sup>

Somadeva will now give a brief account of the apparatus after having consulted innumerable works on chemistry.<sup>2</sup>

1

### DOLĀ YANTRAM

Dolā yantram : a pot is half-filled with a liquid and a rod placed across its mouth from which is suspended the medicine tied in a piece of cloth. The liquid is allowed to boil and a second pot<sup>3</sup> inverted over the first.

3-4

(1) *Vide* illustrations : Appendix II.

(2) This chapter also is evidently quoted from the work of Somadeva.

(3) Unless otherwise stated earthen pots are meant.

## SVEDANĪ YANTRAM

Svedanī yantram : a pot with boiling water has its mouth covered with a piece of cloth and the substance to be steamed is placed on it and a second pot arranged in an inverted position over the rim of the first.

5

## PĀTANĀ YANTRAM

Pātanā yantram [lit. apparatus for sublimation and distillation] : two vessels are adjusted so that the neck of the one fits into that of the other. The junction of the necks is luted with a composition made of lime, raw sugar, rust of iron and buffalo's milk. [Tedious details are given as to the exact measurement of the vessels.]

6-8

## ADHASPĀTANĀ YANTRAM

Adhaspātanā yantram : a modification of the above apparatus in which the bottom of the upper vessel is smeared with the substance, the vapour or essence thereof condensing into the water of the lower one. Heat is applied on the top of the upper vessel by means of the fire of dried cow-dung cakes.

9

## DHEKĪ YANTRAM

Dhekī yantram : below the neck of the pot is a hole into which is introduced the upper end of a bamboo tube, the lower end of it fitting into a brass vessel filled with water and made of two hemispherical halves. Mercury mixed with the proper ingredients is subjected to distillation till the receiver gets sufficiently heated. 11-14

## VĀLUKĀ YANTRAM (SAND-BATH)

Vālukā yantram (sand-bath : a glass flask with a long neck containing mercurials, is wrapped with several folds of cloth smeared with clay and then dried in the sun. The flask is buried up to three-fourths of its length in sand and placed in an earthen pot whilst another pot is inverted over it, the rims of both being luted with clay. Heat is now applied till a straw placed on its top gets burnt. 34-36

## LAVANA YANTRAM

If in the above apparatus salt is substituted for sand, it is called lavana yantram (salt-bath). 38

## NĀLIKĀ YANTRAM

If in the above an iron tube be substituted for the glass flask, it is called nālikā yantram. 41

Place the crucible containing chemicals inside a mass of sand and apply heat by means of cow-dung cakes. This is known as the Bhūdhara yantram.

## TĪRYAKPĀTANĀ YANTRAM

Tīryakpātanā yantram (lit. distillation *per descensum*): place the chemicals in a vessel provided with a long tube, inserted in an inclined position, which enters the interior of another vessel arranged as receiver. The mouths of the vessels and the joints should be luted with clay. Now urge a strong fire at the bottom of the vessel containing the chemicals, whilst in the other vessel place cold water. This (process) is known as tīryakpātanām.

48-50

## VIDYĀDHARA YANTRAM

Vidyādhara yantram is for the extraction of mercury from cinnabar. [Two earthen pots are

arranged as in the illustration. The upper one contains cold water and the mercury condenses at its bottom.]

57-58

### DHŪPA YANTRAM

Dhūpa yantram (lit. fumigating apparatus): bars of iron are laid in a slanting position a little below the mouth of the lower vessel and gold-leaves are placed over them and at the bottom of the vessel is deposited a mixture of sulphur, realgar, orpiment, etc., A second vessel, with its convexity turned upwards, covers the mouth of the lower one and the rims are luted with clay. Heat is now applied from below. This is called fumigation of gold-leaves. Silver may also be similarly treated.

70-74

[This chapter concludes with a detailed description of mortars and pestles—their sizes, measurements, &c.]

## BOOK X

### ON THE INGREDIENTS FOR CRUCIBLES, &c.

Earth which is heavy and of a pale colour, sugar or earth from an ant-hill or earth which has

been mixed with the burnt husks of paddy, fibres of the hemp plant, charcoal and horse-dung pounded in an iron mortar and also rust of iron are to be recommended for crucible-making. 5-6

### VRINTAKA CRUCIBLE

A crucible of the shape of the fruit of *brinjal* (*Solanum melong*) to which is attached a tubulure, which is expanded towards its mouth like the flower of *Datura* s., . . . and which is either 12 or 8 digits in length, is suitable for the extraction of the essence of calamine and other readily fusible minerals. 23-24

[The particular kind of crucible described here is the same as referred to in the extraction of zinc from calamine in the couplets 157-161, Bk. II.]

[Here follows a tedious account of the different kinds of crucibles to be used for different chemical operations.]

### CALCINATION, ROASTING, &C.

When metals have undergone roasting they cannot be roasted to their former condition (*i.e.* they lose their own properties) and they acquire

superior qualities, fill up the lines in the fingers and do not sink in water.<sup>1</sup> 51

A quadrangular pit 2 cubits in length, breadth and depth respectively is filled with 1,000 cow-dung cakes. The drugs to be roasted are placed in one crucible; this is covered with a second, the rims being luted with clay. The crucibles are deposited over the cow-dung cakes and 500 more thrown over them: fire is now applied. 54-55

[The description given above is that of a typical roasting pit. The size of the pit, as also the number of cow-dung cakes often varies according to requirements. It is unnecessary to reproduce the *minutiæ*.]

### THE METALS

The six metals are: gold, silver, copper, tin, lead and iron. Kāmsya and pittala (see p. 114) are artificially made [*i.e.* alloys]. 70

### THE SALTS

The six salts are: sāmudram (lit. derived from the evaporation of sea-water); saindhava (or rock-

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(1) Cf. VIII. 25-28; also *ibid.* 39, pp. 118-119.

salt); *vidam*, sauvarchala, romaka and chulikā lavana.<sup>1</sup>

### THE ALKALIES

The 3 alkalies are : carbonate of potash, carbonate of soda (trona or natron) and borax. 71

### THE OILS

[A list of plants is given from the seeds of which oil is expressed.] 73-75

### THE FATS

The fats of the jackal, the frog, the tortoise, the crab, the dolphin, the ox, the pig, man and also of the goat, the camel, the ass, the ship and the buffalo are to be used. 76-77

### THE URINES

The urines of the elephant, the she-buffalo, the ass and the horse are to be used. (Cf. *ante* p. 30). 78

### THE ACIDS

The acids are : *rumex vesicarius*, the citrons

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(1) A syn. for navasāra (salammoniac), see p. 97.

and lemons, *oxalis corniculata*, tamarind, the acid exudation of *cicer arietinum*, *zizyphus jujuba*, pomegranate, *averrhoa carambola*—these are the acids well suited for the purification, dissolution and killing of mercury and the minerals.<sup>1</sup> 80-84

### THE EARTHS

Brick, red ochre, saline deposits, ashes, earth from ant-hills—these 5 kind of earth are recommended by the experts. 85

### THE POISONS

*Kālakuta*, *aconite ferox*, *sringika* and the biles of animals are the chief poisons. 86

The minor posions are :—*gloriosa superba*, *strychnos nux vomica*, *nerium odorum*, *anacardium semicarpus*, *datura stramonium*, *calotropis gigantea*.<sup>2</sup>

(1) See under Mineral Acids.

(2) The information on the poisons is most elaborate in Susruta from whom our author evidently borrows the classification as given later on in Bk. XV; namely : खादः, जङ्गलः, कृत्रिमः or vegetable, animal and artificial poison. It is worthy of note that opium is not included among the minor poisons.

## THE SOLVENTS

Treacle, *bdellium*, *abrus precatorious*, clarified butter, honey, borax—these are used for helping the fusion of the most infusible metals and hence they are classed among the solvents. 100

## BOOK XI

## ON THE PURIFICATION OF MERCURY

I am now going to describe briefly the various processes for the purification of mercury after having consulted *Rasārṇava* and other works. 10

There are 3 natural impurities in quicksilver, *visha* (poison), *vanhi* (fire) and *mala* (dirt, dregs) and two artificial, due to its being alloyed with lead and tin.<sup>1</sup> 14-15

(1) Cf. *Rasendrachintāmaṇi*.

मिश्रितौ चेद्रसे नागवङ्गौ विक्रयहेतुना ।

ताभ्यां स्थात् कृत्रिमीदोषः तन्मुक्तिः पातनचयात् ॥

"Trades-people fraudulently adulterate quicksilver with lead and tin, hence it is to be freed from these artificial defects [impurities] by means of three distillations" as given above under *Tiryakpātānā* (p. 124).

Hence for the purification of mercury, the operations (named below) are to be undertaken with the aid of appliances and skilled assistants. 20

In an auspicious day and under the influence of a benign star, a quantity of mercury weighing 2,000 or 1,000 or 100 or 18 or 10 *palas* is to be taken and the operation begun. 21-22

[It is useless to enter into the details of the several processes described here ; they are more or less repetitions of what has already been given.]

Pātanavidhi : [purification of mercury by distillation as described in the foot note p. 130.] 33

### FIXATION OF MERCURY.

Rasavandha : processes for destroying the fluidity of mercury :

Take mercury and one-fourth its weight of *killed* gold and with the addition of sulphur make a ball. Now add an equal weight of sulphur and roast the mass in a covered crucible.<sup>1</sup> 72

The mercury thus treated is afterwards killed

(1) In other works a glass retort is recommended.

with six times its weight of sulphur.<sup>1</sup>

73

### INCINERATION OF MERCURY

[The chapter concludes with certain recipes for the killing of mercury, with the aid of purely vegetable products.]

Mercury, roasted in a covered crucible with asafœtida, which has been previously digested in the milky juice of *figus oppositifolia*, is reduced to ashes.<sup>2</sup>

III

*Andropogon serratus* and *clitorea ternatea* are to be pounded in a mortar with sour gruel and with the paste thus formed, mercury is to be triturated and digested 7 times and finally roasted in

(1) The shining reddish brown crystalline sublimate of sulphide of mercury thus obtained is a favourite and frequently-used remedy with the Hindu physicians. It is reputed to be a panacea for a variety of ills that flesh is heir to. In the "Rasendrachintāmaṇi," "Rasendrasārasaṃgraha" and other treatises, this preparation is described as "Makaradhvaj" and "Rasasindūra" (lit. minium-like mercury). From the supposed presence of gold it is often named "Svarnasindūra" (lit. gold and vermilion). During sublimation, the gold of course is left behind. The general belief is that by association with gold the mercury acquires most potent efficacy. A later work, Rasapradīpa, is sceptical about the part which gold plays and recommends its being left out.

(2) Sārṅgadhara also gives a similar recipe.

a covered crucible after addition of fresh quantities of the above paste. The mercury is reduced to ashes, resembling salt. 112-113

The seeds of *achyranthes aspera* and *ricinus communis* are to be pounded together. The mercury is to be placed inside the powder and the mass roasted as before. The mercury is reduced to ashes.<sup>1</sup> 114

Purified mercury is to be preserved in the hollow of a horn or tooth or of bamboo. 119

\* \* \* \* \*

Here ends chapter XI of "Rasaratnasamuchchaya," which treats of the purification fixation and incineration of mercury.

### Notes on the Minerals

Diamond: Belief in the combustibility, of diamond (*vide* pp.101-2) was an accepted creed with

(1) Cf. Rasendrachintāmaṇi, which evidently quotes from a Tāntric work: "O Goddess, I shall now enumerate the substances which ~~kill~~ mercury, without the use of sulphur." A list of 41 plants is given of which any ten may be employed at a time for the roasting operation. The names of the following among others occur in the list: *vitis quadrangularis*, *andropogon serratus*, *plumbago seylanica*, *clitoræa ternatea*, milky juice of *calatropis gigantea* and of *euphorbia neriifolia*; *vitex negundo*, *datura stramonium*, *achyranthes aspera*, *figus oppositifolia* and *tinospora cordifolia*

the Hindu Iatro-Chemists. The reader will find much useful information in the following extract.

'This combustibility of the diamond appears to have been observed at an early period, although the fact does not seem to have attracted the general attention of the older chemists, as statements of a contrary character are recorded by them. Thus, for instance, Kunkel states that his father, at the command of Duke Frederick of Holstein, heated diamonds in his gold-melting furnace, for nearly thirty weeks, without their undergoing any change. It is to Newton, however, that we owe the first argument which went to prove that the diamond was capable of undergoing combustion on account of its high refractive power, a property characteristic of the class of oily bodies. In the second book of his *Opticks*, Newton says upon the subject, "Again the refraction of camphire, oyl-olive, lint-seed oyl, spirit of turpentine and amber, which are fat sulphureous unctuous bodies, and a diamond, which probably is an unctuous substance coagulated, have their refractive powers in proportion to one another as their densities without any considerable variation." The conclusion to which Newton was led by theoretical considerations was experimentally proved to be correct in the year 1694-5 by Averami

and Targioni, members of the Academia del Cimento, who, at the request of the Grand Duke Cosmo III., of Tuscany, placed a diamond in the focus of a large burning-glass and observed that it entirely disappeared. Francis I., who is said to have received from an alchemist an anonymous receipt for melting diamonds, exposed, in the year 1751, diamonds and rubies of the value of 6,000 gulden for twenty-four hours to the action of a powerful fire; the rubies were found unaltered, but the diamonds had altogether disappeared. The volatilization of the diamond by means of heat was from this time forward made the subject of numerous experiments. Thus, Darcet observed in 1766 that diamonds disappear when they are heated in a cupel-furnace, even in closed crucibles, but, continuing his experiments at the request of the Paris Academy, he, together with Rouelle, found that when heated in perfectly hermetically-sealed vessels, the diamond did not disappear. Macquer, in the year 1771, was the first to observe that when the diamond undergoes volatilization it appears to be surrounded by a flame. In conjunction with Cadet and Lavoisier, he afterwards found that a true combustion takes place. In continuation of these experiments Lavoisier, together with Macquer, Cadet,

Brisson, and Baumé,<sup>1</sup> placed a diamond in a glass vessel containing air collected over mercury, and on igniting the diamond by means of a burning-glass, they found that carbonic acid gas was produced."—Roscoe and Schor. Vol 1. pp. 658-59.

Mr. T. H. Holland, F.G.S., A.R.S.M., of the Geological Survey of India, to whom was submitted the translation of the descriptions of the minerals (*vide* pp. 79-100), has favoured me with his opinion, which is reproduced below in his own words. It will, to a certain extent, help in the identification of the minerals.

"I have appended notes giving suggestions which may help to explain some of the passages, but the majority of descriptions are altogether too vague to permit identification of the minerals. The names of minerals already given are presumably recognised translations; for the descriptions accompanying the names might just as well, in many instances, apply to several minerals known in this country.

"Vaikrānta has 8 faces and 6 angles" &c., (p. 83) possibly refers to a mineral crystallizing in the octahedral form, and of the many minerals crystallizing in this form the family of spinels is

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(1) Lavoisier : *Œuvres*, tome ii. 38, 64.

more likely to exhibit the great range of colours given.

“White”—Unknown.

“Red”—Ruby spinel.

“Yellow”—Rubicelle (orange to yellow): dysluite (yellowish brown).

“Blue”—Almandine (violet).

“Grass-green”—chlorospinel, hercynite (black when massive, green by transmitted light and in powder), pleonaste (dark-green);

“black”—magnetite, gahnite, franklinite &c.;

“variegated”—some magnesia spinels;

8 Faces and 6 angels” might possibly also refer to the hexagonal prism with basal planes, a common form of corundum, which gives the variety of colours referred to even more perfectly than the spinels.

But the remarks on p. 104 as to the “liquefaction” of this mineral, cannot apply to either spinel or corundum. Unless there is some failure to appreciate the original meaning the statements are nonsensical.

Mākshikam (pyrites) . . . . Pyrites is of two kinds—golden and silvery; the former is a native of Kanauj, and is of golden yellow colour. The silvery pyrites is associated with stones and

is of inferior quality."

Mākshika repeatedly steeped in [organic substances] and gently roasted in a crucible yields an essence of the appearance [in the shape] of copper' (p. 84.)

Iron pyrites [ $\text{Fe S}_2$ ] is brass-yellow in colour, and its dimorphous form marcasite is pale bronze-yellow; but there are other pyrite-like minerals which are silvery white; for instance, cobaltite ( $\text{Co S}_2$ ,  $\text{Co. As}_2$ ), smaltite ( $\text{Co As}_2$ ), löllingite ( $\text{Fe As}_2$  with S) and leucopyrite ( $\text{Fe}_3 \text{ As}_4$ ). Iron pyrites roasted in air would give a red residue of  $\text{Fe}_2 \text{ O}_3$ . But it seems more likely that the "golden-yellow" variety is copper-pyrite, which has a deep yellow colour and besides which iron-pyrite when freshly fractured would appear almost silvery in colour. In that case the "essence of the appearance of copper" might be the metal itself.<sup>1</sup>

"Sasyaka (blue vitriol) has the play of colours in the throat of the peacock." (p. 86.)

The experiments referred to might apply to any copper compound. There is a copper ore, bornite or erubescite ( $\text{Cu}_5 \text{ Fe S}_4$ ), which, on account of its

(1) Vimala (pp. 84-85) would appear also to be a variety of pyrites.

peculiar colour and iridescence, is known as "peacock" ore. It occurs in several parts of India.

Gairika: hematite, which is red and often hard, and limonite which is yellow or brown, both occur in the form of ochres.

'*Kamkushtam* is produced at the foot of the Himālayas . . . it is of white and yellow colour and is a strong purgative."

Possibly an efflorescence of magnesium sulphate or sodium sulphate; both are not uncommon. The yellow colour might be due to admixture with ferruginous dirt due to oxidation of the ferrous sulphate produced by similar causes with the other sulphates.

Vajram: the remarks "8 faces and 6 corners" would be correct for an octahedral crystal of diamond; but I know of no crystal form which has at the same time "8 angles." The faces of the diamond are frequently rounded, which may account for the statements about the "female" and "neuter" diamonds. Many transparent minerals give a play of colours through either schillerization or refraction; but the diamond is of course particularly noticeable on account of its high dispersive power."

The following extracts from Ball's "Economic Geology of India" will also throw considerable

light on this subject. It will be seen how in India the traditions of the technical arts of which we get vivid glimpses in the *Rasārnava* have been preserved even to our own days from time immemorial.

“Rājputanā—Copper ores are found in several of the independent States of Rājputanā, and also in the British district of Ajmīr. Mining has been practised on a large scale, but at present the trade of miner is becoming extinct and the operations, which are only carried on in a few of the localities are of a very petty nature.

“The names of the States in which there are mines are as follows: Alwar, Bhartpur, Jaipur, Udepur, Bundi and Bikanir.

“Alwar State.—According to Mr. Hacket there are ancient copper mines at the following localities in this state: Daribo, Indawas, Bhangarh, Kusalgarh, Beghani, Pratabgarh, Tassing, and Jasingpura. The most important of this is the first.

“Deribo.—The mine is situated on a sharp anticlinal bend in a thin band of black slates intercalated in the Alwar quartzites. There appears to be no true lode; the one, which is pyrites mixed with arsenical iron, occurs irregularly disseminated through the black slates, a few specks and stains only being seen in the quartzites; occasionally rich

nests of ore were met with . . . . From an interesting account by Major Cadell, the following facts regarding the manufacture have been extracted. The ore, as usual in the native process, is pounded, made up into balls with cow-dung, roasted, and then smelted in a closed furnace and refined in an open charcoal fire. Thirty pounds of ore require four times that quantity of charcoal and yield  $5\frac{1}{2}$  pounds of metal, or 16.6 per cent. During the last 12 years the average annual output has been only 3 tons 8 cwt., and it is diminishing owing to the influx of European copper.

“Singhana (Jaipore State).—The copper mines at Singhana are situated in rocks belonging to the Arvali series. The earliest account of these mines, which is believed to have been by Captain Boilcan, was published in the year 1831. The principal productions were copper, blue vitriol or copper sulphate, alum, and an ore of cobalt called *sehta* or *saita*.

“The mines are described as being tortuous and of great extent; at the working faces it was the custom to light fires which caused the rock to split up. Lamps were used which the miners carried on their heads and with a gad and hammer extracted the ore. The principal ore found appears

to have been pyrites. It was sold retail by auction to the proprietors of different furnaces.

“ The pounding or crushing was effected on a stone anvil with a hammer weighing eight or ten seers ; when completely reduced to powder the ore was made up into balls with cow-dung and roasted. The blast furnaces (*vide illustrations*) were prepared in the following manner. A quantity of common sand was spread on the door of a circular hut, in the centre of which a depression, 12 to 15 inches in diameter and 2 or 3 inches deep, was made ; in this a layer of fine sand and another of ashes were laid to prevent the metal from adhering to the bottom of the receiver ; two clay nozzles or tuyères were then placed on opposite sides of this hollow and a third between them, leaving the fourth side vacant for the slag to escape. The nozzles were then connected by moist clay and a circular rim of mud, a few inches in height, was raised, on which three annular vessels of fire-clay were placed to form the body of the furnace, each of these was 15 inches in external diameter, 10 inches high, and 3 inches thick. They were used repeatedly, but the lower part of the furnace had to be reconstructed for every charge. The bellows were simply goat-skins connected with the nozzles,

and were worked by the families of the smelters. After a preliminary firing, to dry the mud, the furnace was charged with charcoal, roasted ore and iron slag, the latter being employed as a flux.

“In a day of nine or ten hours’ duration, 3 maunds of charcoal,  $2\frac{1}{2}$  of the roasted ore, and 2 of the iron slag were consumed. The slag was drawn off and the smelted copper which had accumulated at the bottom of the furnace was removed on the following day. It was then re-melted and refined in an open furnace under a strong blast from bellows, and cast into small bars or ingots, which were subsequently removed to the Mint and cut up and fashioned into coins.

“The ore was said to yield only from to  $2\frac{1}{2}$  to  $7\frac{1}{2}$  per cent. of metal, but the profits must have been not inconsiderable as the Khetri Rājā is said to have claimed one-sixth of the value of the copper in addition to Rs. 14,000 received for the lease. The quality of the metal is said to have been inferior to that of Basawar, this being attributed to the use of the iron slag as a flux . . . . .  
 . . . Considerable quantities of blue vitriol (copper sulphate), alum, and copperas (iron sulphate) are manufactured from the decomposed slate and refuse of the mines. The slates are

steeped in water, which is afterwards evaporated in large iron vessels, when the blue vitriol, is crystallized out, afterwards the alum, and lastly the copperas. Mr. Mallet found traces of nickel and cobalt in all three of these substances.

“Copper smelting in the Singhbhum District (Bengal).—Indications exist of mining and smelting having been carried on in this region from a very early period, and the evidence available, points to the Seraks or lay Jains as. being the persons who, perhaps 2,000 years ago, initiated the mining.<sup>1</sup> The number and extent of the ancient workings testify to the assiduity with which every sign of the presence of ore was exploited by these early pioneers and those who follow them up to recent times.”

The Treatise on Alchemy attributed to Bubacar (10th to 11th century A. D.) also contains many similar descriptions of the gems and minerals; specially noticeable is the classification according to sex—*male* and *female* (cf. Bk. IV, 27-28, p. 100). We append below one or two short extracts.

“Viennent ensuite les treize genres de pierres, savoir: les marcassites, les magnésies, les tuties,

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(1) Proc. As. Soc. Bengal, June 1869, p. 170.

l'azur (lapis lazuli ou cinabre ?), l'hématite, le gypse, etc., et toute une suite de minéraux désignés sous des noms arabes. Parmi les marcassites (sulfures), on distingue la blanche, pareille à l'argent ; la rouge ou cuivrée ; la noire, couleur de fer ; la dorée, etc.

“Les magnésies <sup>1</sup> sont aussi de différente couleur, l'une noire, dont la cassure est cristalline,<sup>2</sup> une autre ferrugineuse, etc. Une variété est dite mâle ; une autre, avec des yeux brillants, est appelée femelle ; c' est la meilleure de toutes.

“Les tuties <sup>3</sup> sont de différentes couleurs : verte, jaune, blanche, etc.”

“La classe des vitriols (*atramenta*) comprend six espèces : celui qui sert à faire du noir, le blanc, le calcantum, le calcande, le calcathar, et le surianum. Il y en a un jaune, employé par les orfèvres ; un vert mêlé de terre, employé par les mégissiers, etc.”—“La Chimie au moyen âge,” T. I., 307.

(1) Ce mot désignait certains sulfures et oxydes métalliques, tels que les oxydes de fer magnétique, le bioxyde de manganèse, etc.

(2) Offre des yeux brillants.

(3) Oxydes et minerais de zinc, renfermant du cuivre.

## ALUM AND GREEN VITRIOL

Dutt speaking of alum states: "it is not mentioned by Susruta, in his list of metallics, but later writers give its synonyms and uses." This is evidently incorrect. Alum, with green vitriol, is distinctly referred to in the Susruta, *e. g.*:

काशोसं चिह्नतादनीं हृदितानं सुराष्ट्रजा ।

Sūtra. xxxvi, 12.

In the above sloka *surāshtrajā*, lit., begot of Surāshtra (modern Surat), is used in the sense of alum. From the ancient times the "earth of Surat" has been known to yield this mineral. Amara Simha in his Lexicon, written sometime between 400-600 A. D.,<sup>1</sup> gives among others the following synonyms of alum:—*kāmkshī*, *tuvarī* and *surāshtrajā*. "*Rasaratnasamuchchya*" also gives the same synonyms. (Bk. III., 59-62). The manufacture of alum survives to our own days, as the following description will show:

"Alum shales, so called, are of rare occurrence in peninsular India, and, so far as it known, the

(1) The lowermost limit of his age may be taken about 948 A. D. as made out from an inscription in Budh Gaya.

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only considerable native manufacture is situated in Rājputana; but as will be gathered from what follows, the tertiary rocks of the extra-peninsular regions often contain such shales.

“In two localities lumps of alum...occur naturally in sufficient abundance to be a regular article of export.

“Alum is principally used as a mordant in dyeing, but as a drug its employment is extensive in India.

“BEHAR.—Captain Sherwill in 1846 <sup>1</sup> stated that a small quantity of alum was manufactured from slates obtained in the district of Shahabad; these rocks, it is believed, belonged to the Bijigrah pyritous shales of the Kaimur group of the Vin-dhyan series.

“The alum was sold at the high price of one rupee per *tola*; it was identical with the *salajit* of Nepal. Copperas or iron sulphate is obtained in the same region, which is situated to the north of Rotasgarh, and to the west of the Sone.

“Rājputana, Khetri, and Singhana.—In connection with the copper mines at the above localities

(1) Journ. As. Soc. XV., p. 58.

there are manufactories which turn out considerable quantities of blue vitriol (copper sulphate), copperas (iron sulphate), and alum. The process has been very fully described and illustrated by Colonel Brooke. In 1864 there were twenty of these factories at Khetri and about double the number at Singhana. The broken shale from the mine which contains the salts is placed in earthen *gharas*, together with the crusts from the refuse heaps of previous lixiviations and water is added. The *gharas* are arranged on ledges prepared for the purpose on the heaps of refuse, as will be seen by reference to the wood-cut (*vide illustrations*).

“Each charge of shale is exposed to three changes of water and the water itself is changed from one *ghara* to another till it has taken up the sulphates from seven different steepings. It is then of a thick dirty-bluish colour and is taken to the boiling house, where it is boiled in earthen *gharas*; when sufficiently concentrated it is left to cool, and thin sticks being introduced the blue vitriol crystallizes on them. The mother liquor is then poured off and again boiled, and on the addition of saltpetre, the alum crystallizes at the bottom of the vessel. The residual sulphates still in solution, are allowed to crystallize out by ex-

posing the mixture to the sun.

\* \* \* \* \*

“CUTCH.—There are numerous accounts of the manufacture of alum in Cutch. The earliest is by Captain Mc Murdo, who states that before 1818 the exports of alum amounted in some years to several hundred thousand maunds, which chiefly went to Guzerat and Bombay to be employed in dyeing. The following account by Mr. Wynne is the most recent and complete. The site of the operations is at Mhurr or Madh.

“The rock containing the materials is a pyritous dark-gray or black shale, which is in close association with a soft aluminous pseudo-breccia of the sub-nummulitic group.

“This shale is excavated from pits and is exposed for four months, a slow combustion taking place owing to the decomposition of the pyrites.

“It is then spread in squares resembling salt pans and sprinkled with water. After about 12 days it consolidates into efflorescing mammillated crystalline plates or crusts called *phitkari-ka-bij* or seed of alum. These crusts are boiled in large iron vessels (luted inside with lime), together with saltpetre (or other potash salt), in the proportion of 15 of ‘alum seed’ to 6 of the latter ; when it has

settled, the liquor is placed in small earthen vessels somewhat the shape of flower-pots, and crystallization takes place in three days. These crystals are again boiled one or more times to concentrate the solution, which is finally ladled into large thin bladder-shaped earthen *mutkās* or *gharās* with small mouth; these are sunk into the ground to prevent their breaking, and in five days the alum is found crystallized in masses. The vessels are then broken and the alum is stored.

“Alum is also manufactured from the water of a hot spring north of Mhurr. The impure saltpetre, which is employed to supply the second base in the above-mentioned manner, is obtained by lixiviation of village refuse.” (Ball’s “Economic Geology”, pp. 431-33).

“IRON SULPHATE.—The green vitriol or copperas of commerce, which is known to the natives as *kahi* and *hara kāsīs*, is produced principally from the so-called alum shales from which alum is prepared. As is the case also with alum, copperas is found sometimes as a natural exudation upon alum shales and other rocks which include iron pyrites.

“This native copperas goes by several different names in India, according to the nature of the other substances with which it is combined.

“BEHAR.—In the year 1833, Mr. J. Stevenson published an analysis of native sulphate of iron obtained from Behar, which was at that time used by the native dyers of Patna.

He found that it consisted of—

|               |   |   |   |   |      |
|---------------|---|---|---|---|------|
| Iron sulphate | . | . | . | . | 39'0 |
| „ peroxide    | . | . | . | . | 36'0 |
| Magnesia      | . | . | . | . | 23'0 |
| Loss          | . | . | . | . | 2'0  |

*ibid* p. 419.

100'0

tempering of steel. The blades of Damascus were held in high esteem but it was from India that the Persians and, through them, the Arabs learnt the secret of the operation.<sup>1</sup>

The wrought-iron pillar close to the Kutub near Delhi which weighs ten tons and is some 1500 years old; the huge iron girders at Puri; the ornamental gates of Somnath and the 24-ft wrought-iron gun at Nurvar—are monuments of a bye-gone art and bear silent but eloquent testimony to the marvellous metallurgical skill attained by the Hindus. Regarding the Kutab pillar, Fergusson says: "It has not, however, been yet correctly ascertained what its age really is. There is an inscription upon it, but without a date. From the form of its alphabet, Prinsep ascribed it to the 3rd or 4th century; Bhau Daji, on the same evidence, to the end of the 5th or beginning of the 6th century. The truth probably lies between the two. Our own conviction is that it belongs to one of the Chandra Rajas of the Gupta dynasty, either subsequently to A. D. 363 or A. D. 400.

(1) *Vide Trempe du Fer Indien*: "Elle a été découverte par les Indiens et exposée par les Perses, et c'est de ceux-ci qu'elle nous est venue."—Berthelot: "Coll. Alch Grec.," T. 3, *trad.* p. 332.

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“Taking A. D. 400 as a mean date—and it certainly is not far from the truth—it opens our eye to an unsuspected state of affairs to find the Hindus at that age capable of forging a bar of iron larger than any that have been forged even in Europe up to a very late date, and not frequently even now. As we find them, however, a few centuries afterwards using bars as long as this *lat* in roofing the porch of the temple at Kanaruc, we must now believe that they were much more familiar with the use of this metal than they afterwards became. It is almost equally startling to find that after an exposure to wind and rain for fourteen centuries, it is unruined, and the capital and inscription are as clear and as sharp now as when put up fourteen centuries ago.

“There is no mistake about the pillar being of pure iron. Gen. Cunningham had a bit of it analysed in India by Dr. Murray, and another portion was analysed in the School of Mines here by Dr. Percy. Both found it pure malleable iron without any alloy.” “Hist. of Indian and Eastern Architecture,” p. 508 ; ed 1899.

The Ritter Cecil von Schwarz, who was for sometime in charge of the Bengal Iron Works Company, thus speaks of the superior iron smelting

industry in India :—

“It is well-known by every manufacturer of crucible cast-steel how difficult it is sometimes to get the exact degree of hardness to suit certain purposes, especially with reference to steel for cutting the blades, etc., With the ordinary process, endeavours are made to reach the required degree of hardness by selecting such raw materials as on an average have the required contents of carbon in order to correspond with the required degree of hardness as far as possible. The natives [of India] reached this degree by introducing into their cast-steel an excess of carbon, by taking this excess gradually away afterwards, by means of the slow tempering process, having it thus completely in their power to attain the exact degree by interrupting this de-carbonising process exactly at the proper time in order to cast steel of a quality exactly suitable for the purpose.”

## ZINC

The extraction of zinc from the ores can be followed in every detail from the account left us both in “*Rasārṇava*” and “*Rasaratnasamuchchaya*.”

"Rasaka" is mentioned in Rasārṇava as the mineral which turns copper into gold (p. 71). We have also in the succeeding couplets a process described for the reduction of the ore. This process is so elaborately given in R. R. S. that it may be quoted almost *verbatim* in any treatise on modern chemistry; it is practically the same as distillation *per descensum*—the flame of bluish tint issuing from the mouth of the crucible indicates the combustion of carbon monoxide, so often observed in metallurgical operations.<sup>1</sup> (See p. 88).

From the time of the Susruta to that of R. R. S., we find all along six metals recognised (see pp. 48 and 127) and the last work distinctly mentions brass and bell-metal as simply alloys. Owing to the veneration paid to ancient authorities, the Indian alchemists had at first some hesitation in classing "the essence of the lustre of tin" "वङ्गमस" (p. 71) as a separate metal. In the medical Lexicon ascribed to king Madanapāla and written about the year

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(1) Cf. "A mixture of 2 parts of ground roasted ore and 1 part of coal dust is brought into the retorts, each holding about 40 lbs. of the mixture. As soon as the temperature has risen high enough, the reduction begins and *carbon monoxide is evolved and burns* from the end of the clay adapter *with a blue flame* (the italics, are ours). Roscoe and Schorlemmer's Chemistry, Vol. II., Pt. I p. 255, ed. 1879.

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1374 A. D.,<sup>1</sup> zinc is, however, distinctly recognised as a metal under the designation of *Fasada*.<sup>2</sup>

It is evident that *rasaka* is the *cadmia* of Dioscorides and Pliny and *tutia* of the alchemists of the middle ages. The pseudo-Basil Valentine writing about 1600 A. D. uses the word zinc but "he does not appear to have classed it with the metals proper." Paracelsus mentions zinc sometimes as a metal and sometimes as a *bastard* or *semi-metal*, but it is doubtful whether he had any distinct notion of its true character specially as he says, "it has no malleability" (*keine malleabilität hat er*) or of the ore which yielded it.<sup>3</sup> "Libavius was the first to investigate the properties of zinc more exactly, although he was not aware that the metal was derived from the ore known as *calamine*. He states that a peculiar kind of tin is found in the East Indies called *Calaëm*. Some of this was brought to Holland and came into his hands." (Roscoe and Schorlemmer).

The terms *rasaka*, *kharpara*, *kharpara-tuttha*

(1) Roth: "Indischen Studien," XIV, 399; also Bühler: Intro. to Manu, CXXV.

(2) असद रङ्गसदृशं दितिहेतुश्च तन्मतम् ।

(3) "Gesch. d. Chemie," IV, 116.

and tuttha are all applied to calamine, while tuttha sometimes stands for blue vitriol as well. Some writers have, however, mistaken kharpara for blue vitriol, but R. R. S. is very explicit on this point. The name *tutenague* by which Chinese zinc was known in commerce is evidently derived from the Tamil *tatanagam*. "In Persian, sulphate of zinc is called *suffed* (white) *tutia*; sulphate of copper, *neela* (blue) *tutia*; and sulphate of iron, *hura* (green) *tutia*; so, in Avicenna, different kinds are described under this name, which occurs also in Geber" (Royle). Both the Tamil *tatanagam* and the Persian *tutia* are probably corruptions of the Sanskrit word *tuttham*. At the beginning of the last century the Baron de Sacy was at considerable pains in tracing the history of *tutia*. In a note appended to certain extracts from Kazwini, the "oriental Pliny," the learned Frenchman gives the following description of *tutia*. The account necessarily involves some digressions on the Aristotelian theory of the formation of dew, hail-stone, metals, &c., and the reader may with advantage compare it with that of the Vaiseshika Philosophy. (Chap. I, pp. 1-12).

"Le *khar-sini* est aussi nommé *fer de la Chine*  
 . . . et *or cru* . . Je crois que ce même

métal est aussi désigné sous les noms de *djosd* ou *djost* dans l'Inde, de *tutie fossile* . . . chez les Arabes, enfin d'*esprit de tutie* . . . dans l'*Ayin Achéri*, et que c'est la *toutenague*, dont il y a plusieurs variétés plus ou moins analogues au zinc.

“ Je vais rapporter, pour mettre le lecteur à portée de juger de ma conjecture, ce que je trouve dans le Dictionnaire des médicamens simples par Ebn-Beïtar, sur les diverses espèces de tutie fossile, et un article curieux de l'*Ayin Achéri*, omis pour la trèsgrande partie dans la traduction anglaise de M. Gladwin; j'en donnerai le texte d'après deux manuscrits de cet ouvrage, dont l'un m'appartient, et l'autre faisoit autrefois partie de la bibliothèque de feu M. Langlès et d'après le Traité de médecine, dédié au prince Dara-schékouh, où il se trouve tout entier (manuscrit de M. Brueix, acquis par la bibliothèque du Roi, n.<sup>o</sup> 16, fol. 62 et suiv.) Je joindrai à cela ce que dit Kazwini de la formation du *khar-sini* et de ses usages médicaux et économiques, laissant aux minéralogistes à juger si, dans ces descriptions mêlées d'hypothèses arbitraires, et de quelques traits suspects de charlatanisme, on peut reconnoître la toutenague.

“ Voici d'abord le passage d'Ebn-Beïtar.

"Edu-Wafid dit : il y a deux espèces de tuties ; l'une se trouve dans les mines, l'autre dans les fourneaux où l'on fond le cuivre, comme la *cadmie* ; cette dernière espèce est ce que les Grecs nomment *pompholyx*. Quant à la tutie fossile, il y en a trois variétés ; l'une blanche, l'autre verdâtre, la dernière d'un jaune fortement rougeâtre. Les mines de celle-ci sont dans les contrées maritimes de la mer de Hind et de Sind : la meilleure est celle qui semble au coup-d'œil couverte de sel ; après celle-ci, la june ; quant à la blanche, elle a quelque chose de graveleux . . . : et est percée : on l'apporte de la Chine. La tutie blanche est la plus fine de toutes les variétés et la verte, la plus grossière ; quant à la tutie des fourneaux, Dioscoride dit, livre V.e. : *Le pompholyx, qui est la tutie, diffère du spodion &c.*"

"L' *Ayin Acbéri* expose la formation des minéraux et celle des métaux en particulier, suivant une hypothèse, commune, je crois, à tous les alchimistes anciens ; et quoique ces détails méritent par eux-mêmes peu d'attention, je rapporterai le passage en entier, 1.<sup>o</sup> parce que M. Gladwin l'a omis ; 2.<sup>o</sup> parce qu'il est nécessaire pour que l'on puisse juger de la nature du *khar-sini* et de l'identité que je suppose entre cette

substance métallique et l'*esprit de tutie*. Il y a dans le texte de l'*Ayin Acbéri* quelques omissions que je rétablirai d'après le Traité dédié à Daraschékoïh, où ce chapitre se trouve tout entier, et il n'est pas le seul qui soit commun à ces deux ouvrages. L'auteur de ce dernier traité, .....  
 ... .., annonce lui-même, fol. 62, verso, qu'il va tirer quelques chapitres sur les métaux, de l'ouvrage de feu Abou'l Fazel, formant le III.<sup>e</sup> tome de l'*Acber-namèh* : l'un de ces textes me servira à corriger l'autre.

#### *De la formation des métaux.*

“Le dieu créateur de l'univers a donné l'existence à quatre élémens en opposition les uns aux autres, et il a suscité quatre êtres d'une nature admirable : le feu chaud et sec, qui possède une légèreté absolue ; l'air chaud et humide, doué d'une légèreté relative ; l'eau froide et homide, qui possède une pesanteur relative, la terre froide et sèche, douée d'une pesanteur absolue. La chaleur produit la légèreté, et le froid la pesanteur ; l'humidité facilite la séparation des parties, la sécheresse y met obstacle. Par la combinaison de ces quatre puissances élémentaires, ont été produits tous les êtres dont l'existence est due

l'influence des corps célestes, les minéraux, les végétaux et les animaux.

“ Les particules aqueuses, ayant acquis par les rayons du soleil et autres causes un plus grand degré de légèreté, se mêlent avec les particules aériennes, et s'élèvent en l'air : c'est cette combinaison que l'on nomme *vapeurs*. Par le moyen de cette combinaison, les molécules terreuses étant mêlées elles-mêmes avec les particules aériennes, s'élèvent aussi en l'air ; et c'est ce qu'on nomme *exhalaisons* : quelquefois aussi les particules aériennes se mêlent [immédiatement] avec les molécules terreuses. Il y a des philosophes qui appliquent également le nom de *vapeurs* à ces deux sortes de combinaisons élémentaires : ils désignent celles qui sont le produit des particules aqueuses, par le nom de *vapeurs humides* ou *aqueuses* ; et celles qui doivent leur formation aux molécules terreuses, par le nom de *vapeurs sèches* ou *fuligineuses*. Ce sont ces deux sortes de vapeurs qui forment au-dessus de la terre les nuées, le vent la pluie la neige et autres phénomènes semblables ; et dans l'intérieur du globe, les tremblemens de terre les sources et les mines. On regarde les vapeurs comme le corps, et les exhalaisons comme l'esprit : des unes et des autres, suivant la diversité de leurs

combinaisons et les différentes proportions dans lesquelles elles s'unissent, sont produites dans le laboratoire de la nature un grand nombre de substances diverses. Suivant ce qu'on lit dans les traités de philosophie, on ne compte pas plus de cinq espèces de minéraux : ceux qui sont infusibles à cause de leur sécheresse, comme le *yakout* ; ceux qui le sont à cause de leur humidité, comme le vifargent ; ceux qui se fondent promptement, mais qui ne sont ni malléable, ni combustibles, comme le vitriol ; ceux qui ne sont pas malléables, mais qui sont combustibles, comme le soufre ; ceux enfin qui sont malléables, mais incumbustibles comme l'or. La fusion d'un corps consiste dans la liquéfaction de ses parties, due à la combinaison de la sécheresse et de l'humidité : la malléabilité [ou ductilité] est la faculté qu'a un corps de recevoir peu à peu une augmentation d'étendue, tant en longueur qu'en largeur, sans séparation d'aucune de ses parties et sans aucune addition.

“ Quand les vapeurs et les exhalaisons se mêlent de manière que les premières soient le principe dominant, et que le mélange étant achevé et la coction parfaite, l'ardeur du soleil coagule cet amalgame, le produit est du vif-argent. Comme il n'y a aucune des molécules de ce produit qui ne ren-

ferme quelque portion d'exhalaison, ce corps a une qualité sèche dont les effets sont sensibles : il ne s'attache pas à la main ; au contraire, il fuit le contact : comme la chaleur a été le principe de sa coagulation, la chaleur ne peut la détruire. Si les deux principes [les vapeurs et les exhalaisons] se combinent dans des proportions à-peu-près égales, il se manifeste dans le mélange une humidité d'une nature visqueuse et onctueuse : à l'instant de la fermentation des particules aériennes s'insinuant dans le mélange qui se coagule alors par le froid, les produits de cet amalgame sont inflammables. Si les exhalaisons et la qualité onctueuse dominant, le produit est du soufre, qui est rouge, jaune, bleu ou blanc ; s'il y a plus d'exhalaisons et peu de principe onctueux, l'amalgame donne l'arsenic qui est rouge et jaune ; enfin si ce sont les vapeurs qui dominant, il se trouve, quand la coagulation est achevée, que le produit est de la naphte qui est noire et blanche. Comme, dans ces amalgames, la coagulation est produite par le froid, ces corps sont fusibles par la chaleur : et à cause de l'abondance de leur qualité huileuse et de leur humidité visqueuse, ils sont susceptibles de prendre feu ; enfin, à raison de leur excès d'humidité, ils ne sont point malléables. Les sept corps [ou métaux] ayant

tous pour principes constituans le vif-argent et le soufre, la variété de ces corps ne peut avoir pour cause que les divers degrés de pureté de ces deux principes, la plus ou moins grande perfection de leur mélange, et la diversité d'influence qu'ils exercent l'un sur l'autre.

“Si les deux principes ne sont altérés par aucun mélange de parties terreuses, s'ils sont dans toute leur pureté naturelle, si enfin ils éprouvent une coction parfaite, alors le soufre étant blanc et le vif-argent dans une proportion plus grande, le produit de l'amalgame est de l'argent ; il est de l'or, si les deux principes sont dans des proportions égales, et que le soufre soit rouge et possède la force colorante. Si, les circonstances étant les mêmes, après le mélange mais avant la parfaite coction, l'amalgame est coagulé par le froid, il se forme du *khar-tchini*, que l'on nomme aussi *fer de la Chine*, ce qui équivaut pour le sens à de l'or cru : quelques-uns le regardent comme une sorte de cuivre.” (La même doctrine sur la formation du *khar-tchini* ou *âhen-tchini*, nommé encore *or cru*, se trouve dans cet ouvrage, fol. 60 *recto*, lig. 1 re et suiv). “ Si le soufre seul n'est pas pur, que le vif-argent domine, et que la force brûlante unisse les deux principes, le produit est du cuivre. Quand

le mélange n'est pas fait convenablement, et que la proportion du vif-argent est la plus forte, il se forme de l'étain : quelques-uns prétendent que l'étain ne se forme pas à moins que les deux principes ne soient l'un et l'autre dans un état de pureté. Si les deux principes sont mauvais et très-altérés, qu'il y ait dans le vif-argent des molécules terreuses interposées, et dans le soufre une qualité brûlante, il résulte, de l'amalgame, du fer : enfin le produit est du plomb, si, les circonstances étant d'ailleurs les mêmes, le mélange ne se fait pas complètement, et que le vif-argent domine. On donne à ces sept substances le nom de *corps* ; on appelle le vif-argent *la mère des corps*, et le soufre *leur père* : on considère aussi le vif-argent comme l'*esprit*, et l'arsenic ainsi que le soufre, comme l'*ame*. Le *djost*, suivant quelques personnes, est l'*esprit de tutie*, et approche du plomb : il n'en est fait aucune mention dans les livres de philosophie. Il y en a une mine dans l'Indoustan, dans le territoire de Djalour, qui fait partie du soubah d'Adjmir.

“ Les alchimistes disent que l'étain est un argent malade de la lèpre, le mercure un argent frappé de paralysie, le plomb un or lépreux et brûlé, et le cuivre un or cru, et que l'alchimiste, semblable à un médecin, remédie à ces maux par des

moyens contraires ou assimilés.

“Les savans qui s'adonnent à la pratique des arts, font, avec ces sept corps, des compositions artificielles dont on se sert pour fabriquer des bijoux, joyaux, &c. Du nombre de ces compositions est le *séfid-rou* [c'est-à-dire, *blanc à l'extérieur*, peut-être le *pé-tong* des Chinois], nommé *cansi* <sup>1</sup> par les Indiens, qui se compose de quatre sères de cuivre et d'un sère d'étain unis par la fusion : le *rouï*, composé de quatre sères de cuivre et d'un sère et demi de plomb, et que l'on appelle dans l'Inde *bahngar* : le *biroundj*, nommé par les Indiens *petel* <sup>2</sup> et dont il y a trois variétés : la première, qui se bat à froid, et contient deux sères et demi de cuivre, et un sère d'esprit de tutie ; la seconde, qui se bat à chaud, composée de deux sères de cuivre et d'un sère et demi d'esprit de tutie ; la troisième, qui ne se bat point, mais qui s'emploie pour les ouvrages jetés en moule et dans laquelle il entre deux sères de cuivre, et un sère d'esprit de tutie : le *sim-sakhtèh* [*argent marqué ou pesé* ; peut-être faut-il lire *soukhtèh*, brûlé],” dans la

(1) *Kámsya*, See p. 114.

(2) *Pittala*, See p. 114.

composition duquel il entre de l'argent, du plomb et du cuivre, dont la couleur est d'un noir éclatant, et qui s'emploie dans la peinture : le *heft-djousch* [*bouilli sept fois*], dans lequel on se contente d'amalgamer six métaux, lorsqu'on n'a pas de *khar-tchini* ; quelques-uns lui donnent le nom de *talikoun* [catholicon] ; mais suivant d'autres, le *talikoun* est un cuivre préparé : l'*escht-dhat*, composé de huit choses, savoir, les six métaux susdits, l'esprit de tutie et le *cansi* ; on le fait aussi avec sept substances seulement : le *caulpatr* composé de deux sères de *séfid-rou*, et d'un sère de cuivre ; il prend une couleur foncée très-agréable. C'est une des inventions de notre saint empereur." <sup>1</sup>

### On the Essence of Minerals

#### CALAMINE

It will be seen Gladwin's rendering of *Āin-i-Ākbari* is not very reliable ; it may, however, be noted here that even Blochmann in his much improved and more accurate translation erroneously

(1) "Chrestomathie Arabe," T. III. pp. 453-58 ed. 1827.

renders *jost* as "pewter." <sup>1</sup> The *rûh i tûtia* (spirits of tutia) is used in the above extract in the same sense as in *Rasārṇava*, which describes zinc as the *svattam* (essence) of *rasaka* (see p. 71). In R. R. S. also we find that blue vitriol yields a "*svattam*," which is no other than copper" <sup>2</sup> (p. 86).

### THE VITRIOLS

From the writings of Dioscorides and Pliny it does not appear that the ancient Greeks and Romans drew any sharp distinction between blue

(1) Vol. I p. 40.

(2) The "essence or spirits of minerals" is used here in a different sense from that of the generality of the Arabian and European alchemists. According to the latter there are four spirits of minerals, namely, sulphur, arsenic, sal-ammoniac and mercury. "Les mots *esprits*, *corps*, *ames*, sont fréquemment employés par les alchimistes dans un sens spécial, qu'il importe de connaître pour l'intelligence de leurs écrits. Les passages suivants, quoique d'une époque plus moderne, jettent beaucoup de lumière sur ce point."

"On lit dans le traité de *Mineralibus*, prétendu d'Albert le Grand (L. I. tr. I, ch. I er): 'ce qui s'évapore au feu est esprit, âme, accident; ce qui ne s'évapore pas, corps et substance.'—"Coll. des Alch Grecs," I. pp. 247-8. Cf. "Le cuivre est comme l'homme; il a corps et âme."—Introd. à la Chimie des Anciens, p. 294. See also, "La chimie au moyen âge," T. I. p. 73, and *ibid.* T. III. pp. 168-70; also *ante* p. 91.

and green vitriol respectively. The word *chalcanthum* was applied now to the one, now to the other.<sup>1</sup> In the Hindu Materia Medica no such confusion occurs. Even in the Charaka and the Susruta *tuttham* (blue vitriol) and *kāsisa* (green vitriol) are mentioned side by side.

### BLUE VITRIOL

The word *tuttham* is generally applied to blue vitriol; in Rasendrasāraṅgraha and Sārṅgadharma, the following synonyms are given : तुल्यके तु शिखियोव  
इससार मयूरकं ।

R. R. S. uses *mayūratuttham* (मयूरतुल्यं) in Bk. ii. 129, which is a combination of the last and the first names in the above *śloka* *Sikhigrīvam* (lit.

(1) "Ich habe schon bei der Geschichte des Eisenvitriols darauf aufmerksam gemacht, welche Unsicherheit in den früheren Mittheilungen über Vitriol im Allgemeinen herrscht. Auch die älteren Angaben, welche am passendsten auf den Kupfervitriol bezogen werden, können zum theil auf Eisenvitriol gegangen sein." "Ges. der Chem." IV. p. 168.

"Observons les sens divers de ce mot couperose [chalcanthon], ou de son équivalent vitriol, tels que : vitriol bleu : sulfate de cuivre ; vitriol vert : sulfate de fer, et sulfate de cuivre basique ; vitriol jaune te rouge : sulfates de fer basiques." "Coll. d. Grecs." I. pp. 241-242.

resembling the neck of the peacock) is practically the same as "mayūrankantha sachchhāyam" in sloka, 127, *i.e.* having the play of colour in the throat of the peacock.

The term sasyaka as a synonym for blue vitriol does not occur in any other medico-chemical work that I have come across except Rasārṇava.

That an essence in the shape of copper is yielded by blue vitriol is worthy of note from a historical point of view. Rasārṇava very often hits upon it but is not so explicit as R. R. S., as it modestly contents itself with the mere assertion that the essence is of the colour of *Coccinella* insect *i.e.* red (see p. 86). In the Bhāvaprakāśa (ca. 1550 A.D.) occurs this remarkable passage: "तत्त्वं तु ताम्रोपधातुर्हि किञ्चित्तामेव तद्वति" *blue vitriol is indeed a semimetal of copper as it is derived from copper.* The nomenclature itself is in wonderful agreement with that adopted nearly two centuries later by Boerhave<sup>1</sup> (1732 A. D.).

(1) "Die krystallisirten Verbindungen eines Metalls mit Säuren erkannte er nicht unbedingt als Salze an; die Vitriole namentlich rechnete er zu den Halbmetallen." Kopp: "Ges. d. Chem. III. p. 6.

Our knowledge of the nature of the "essence" of blue vitriol has thus been gradually advanced from Rasārṇava downwards.<sup>1</sup>

(1) "Basil Valentine" seems to have known that some vitriols contained copper, but his "blue vitriol" does not necessarily mean sulphate of copper. "Der blaue Vitriol. .... heisst bei Basilius vitriolum commune: was bei ihm Vitriolum Veneris gennant wird, ist oft Grünspan, und überhaupt geht diese Bezeichnung bei ältern schriftstellern auf sehr verschiedenartige Kupfersalze, wie denn Libavius in seiner Alchymia (1595) für die Bereitung des vitrioli Veneris vorschreibt..... ." Even Agricola (1494-1555), contemporary of Bhāva does not make any great distinction between green and blue vitriol. "Agricola beschreibt in seiner Schrift *de re metallica* die Darstellung des Kupfrevitriols bei der des Eisenvitriols und des Alauns, ohne die beiden ersteren als wesentlich verschieden anzusehn, und auch in seiner Abhandlung "de natura fossilium" unterscheidet er nur verschieden gefärbte, nicht aber wesentlich verschiedene Vitriole"..... "Ges. d. Chem." IV 170-171.

ON  
Gunpowder, Saltpetre  
AND THE  
Mineral Acids

GUNPOWDER

The ancient Hindus are sometimes credited with the knowledge of the art of manufacturing gunpowder, in support of which the several recipes given in the Sukranīti or the Elements of Polity of Sukrāchārya which we have already had occasion to quote, are cited. Take for example the following:—

सुवर्चिलवणात् पञ्च पलानि गन्धकात् पलम् ।

अन्तर्धूमविपक्वाकंसुद्धाद्यङ्गारतः पलम् ॥ 201

युद्धात् संयाज्य संचूर्ण्य सन्धौल्यं प्रपुटेदसैः ।

कुङ्कुमाकां रसोनस्य शोषयेदातपेन च ।

पिष्टा शर्करवच्चैतदग्निचूर्णं भवेत् खलु ॥ 202

- सुवर्चिलवणशङ्कागाः षड्। चत्वार एव वा ।  
 नालास्त्रार्थाग्निचूर्णे तु गन्धाङ्कारौ तु पूर्व्ववत् ॥ 203  
 गोक्षी क्षीहमयी गर्भघुटिकः केवलोऽपि वा ।  
 सौमस्य लघुनालार्थे क्षान्धधातुभयोऽपि वा ॥ 204  
 क्षीहसारमयं वापि नालास्त्रं त्वन्यधातुजम् ।  
 नित्यसम्प्राज्जनस्त्रक्ष्मस्तपातिभराहृतम् ॥ 205  
 चङ्कारस्यैव गन्धस्य सुवर्चिलवणस्य च ।  
 शिलाया इरितालस्य तथा सौमजस्य च ॥ 206  
 द्विङ्कुलस्य तथा कान्तरजसः कर्पूरस्य च ।  
 जतीर्नील्याश्च सरलनिय्यासस्य तथैव च ॥ 207  
 समन्वनाधिकैरंशैरग्निचूर्णान्यनेकशः ।  
 कल्पयन्ति च तद्विद्याश्चन्द्रिकाभादिमन्ति च ॥ 208  
 क्षिपन्ति चाग्निसंयोगाद्गोलं लक्ष्ये सुनालजम् ॥ 209  
 नालास्त्रं शोधयैदादौ दद्यात्तवाग्निचूर्णकम् ।  
 निवेशयेत्तद्वस्त्रेन नालमूली यथा दृढम् ॥ 210  
 ततः सुगोलकं दद्यात् ततः कर्णेऽग्निचूर्णकम् ।  
 कर्णचूर्णाग्निदानेन गोलं लक्ष्ये निपातयेत् ॥ 211

“ Take five *palas* of saltpetre, one *pala* of sulphur and one *pala* of charcoal, prepared from the wood of *Calotropis gigantea* and *Euphorbia neriifolia* by destructive distillation ’; powder them and mix them intimately and macerate them in the juice of the above-named plants and of garlic and afterwards dry the mixture in the sun and pulverise it to the fineness of sugar. Gunpowder (lit. fire-powder) is thus obtained. 201-202

“ If the fire-powder is to be used for a gun, six or four *palas* of saltpetre are to be taken, the proportion of charcoal and sulphur remaining the same as before. 203

“ For a gun with a light barrel, balls of iron or of other metals are to be used. 204

“ The gun made of iron or of other metals are to be constantly kept clean and bright by the skilful artillerymen. 205

By varying the proportions of the ingredients, *viz.*, charcoal, sulphur, saltpetre, realgar, orpiment, calx of lead, asafoetida, iron powder, camphor, lac, indigo and the resin of *Shorea robusta*, different

(2) अलघ्नविपक्वः lit., (wood) charred by smoke circulating through it.

kinds of fires are devised by the pyrotechnists giving forth flashes of starlight." 206-208

From the circumstantial details given above, especially of the method of preparing the charcoal, one is naturally led to suspect that the lines relating to gunpowder as quoted above are later interpolations. The suspicion is further enhanced when it is borne in mind that in the Polity of Kāmandakī, an ancient work of undoubted authenticity, there occurs no reference whatever to firearms nor is there any in the Agnipurāṇa in which the subject of training in the use of arms and armours takes up four chapters, archery forming the leading element. <sup>1</sup>

The more rational conclusion would be that the Sukranīti is a patch work in which portions of chapter IV were added some time after the introduction of gunpowder in Indian warfare during the Moslem period.<sup>2</sup> Dr. G. Oppert, however, stands up for its antiquity.

In Halhed's "Code of Gentoo Laws," there is a passage which is sometimes quoted as a proof that

(1) See Intro. to Dr. R. L. Mitra's edition of Agnipurāṇa.

(2) Dr. R. L. Mitra, judging from the description of guns alone, concludes this portion to be spurious;—*vide* Notices of Sanskrit Mss. Vol. V, p. 135.

M. Berthelot's concluding remarks on Marcus Græcus' "Book of Fire" are equally applicable to Sukranīti:—

the ancient Hindus knew the use of firearms. Halhed, not having an acquaintance with Sanskrit, had to depend on the Persian translation of the Sanskrit digest prepared by some learned pundits. We have been at some pains in finding out the original text which is generally credited to Manu. It is only by a forced interpretation that anything in Manu may be taken to refer to a projectile discharged from a gun. <sup>1</sup>

“ Mais je n'insiste pas, si ce n'est pour rappeler comment ces additions manifestent le caractère véritable de la composition de ces manuscrits et livres de recettes, déjà répandus dans l'antiquité et dont les formules sont venues jusqu'au XVIIIe siècle, parfois même jusqu'à notre temps. Le *Liber ignium* en est un exemple, et l'analyse précédente montre bien comme il a été composé avec des matériaux de dates multiples, les uns remontant à l'antiquité, les autres ajoutés à diverses époques, dont les dernières étaient contemporaines, ou très voisines de celle de la transcription de chaque manuscrit.” “ La Chimie au moyen âge” T. 1.135.

(1) The passage in Manu runs thus :

न कूटे रायुधेर्हत्यादयुध्यमानो रणे रिपून् ।

न कश्चिभिर्नापि दिग्धेर्नाग्निष्वलिततेजनेः ॥ मनु, VII. 90

We give below the commentaries of Medhātithi and Kullūka Bhatta :—

In Sanskrit literature, there are frequent but vague references to 'agni astra' or firearms, but we have no reason to suppose that the combustible matter these fire arms contained supplied a motive power of the nature of gunpowder. The fire missiles were probably of the same category as the

कूटानि यानि वह्निःकाष्ठमयानि अन्तर्निहितशस्त्रानि । कर्षिणः शराः, ये शस्त्रस्य मूले मध्यं वा कर्षाकारैः क्रियन्ते । ते हि प्रविष्टा दुहस्त्रा भवन्ति, प्रहरैरभिन्नमपि शरीरेमदेशं भिन्दन्ति । दिग्धाविषोपलिप्ताः । अग्निना ज्वलितमादौपितं तेजोमयफलकं येषां, एतेनयोज्यम् । इति मेधातिथिः ।

कूटान्वायुधानि वह्निः काष्ठादिमयानि, अन्तर्गूढनिहितशस्त्राणि तेः समरे युद्धमानः शत्रून् न हन्यात् ; नापि कर्षाकारफलकैर्नापि विषाक्तैर्नाप्यग्निप्रदीप्तफलकैरित्यर्थः । इति कुल्लूकभट्टः ।

The correct rendering should be as follows:—"The king shall not slay his enemies in warfare with deceitful or barbed or poisoned weapons, nor with any having a blade *made red hot by fire* or tipped with burning materials"; Bühler, who also follows the above commentators, thus translates: "when he (the king) fights with his foes in battle, let him not strike with weapons concealed (in wood), nor with (such as are) barbed, poisoned, or the points of which are blazing with fire." Whereas Halhed's version is: "the magistrate shall not make war with any deceitful machine or with poisoned weapons or with cannon and guns or with any other kind of firearms."

'Greek fire,' *i.e.* arrows or darts tipped with oiled flax, resin, regalar, naptha or other bituminous substances discharged from bows ; sometimes elaborate machines being devised to hurl the weapons with more deadly effect. In the Udyogaparava of the Mahābhārata, Yudhisthira is described as "collecting large quantities of resin, tow, and other inflammable articles for his great fratricidal war." <sup>1</sup> But there is nothing to show that gunpowder of any sort was in use or any chemical which would act as a propelling agent. <sup>2</sup>

The mention of gunpowder and of some sort of explosives with identical formularies occurs almost simultaneously in the Latin redaction of the work on

(1) See Dr. Mitra's "Antiquities of Orissa," 1.121.

(2) In the 11th century, Kāsmīr remained safe behind its mountain ramparts and was hermetically sealed to all foreigners with out exception. Here, according to Albīrūnī, Hindu sciences retired and took shelter when the Mohammedan invasion of India began. But in the indigenous mode of warfare no reference to gunpowder is to be found ; thus we read in Kalhana's Rajatarāṅgiṇī that in 1060 A. D. "he (Kandarpa) threw into the mêlée burning arrows smeared over with vegetable oil, struck by which the enemies caught fire. Believing that he knew [the use of] the weapon of fire (*agneya astra*), they became frightened and fled in bewilderment, cursing their return."

Stein's Trans. Vol. 1. p. 344.

"Fire" by Marcus Græcus and in the writings of Roger Bacon about the 13th century.<sup>1</sup> Greek fire was introduced into Constantinople from the East about the year 673 and the Byzantians evidently knew that saltpetre was its basis; but they kept this knowledge strictly a secret, and abstained from speaking of it by any distinct name lest the information might leak out. Thus the very word saltpetre

The original passage is

ततस्तानथ नाराचान् निश्चिते स संयुगे ।

लिप्तानौषधितैलेन बिद्धा येः प्राज्वलन् दिशः ॥

आग्नेयं वेत्यसावस्त्रमिति मूर्च्छा विशद्विताः ।

ते दूरं प्रययुर्भीता निन्दन्तः पुन रागमम् ।

VII. 983, 989.

For further references to similar fire-missiles see Mahánátaka or Hanumāna Nátaka in Wilson's "Hindu Theatre," Vol. II. ed. 1835, appendix, pp. 369-70.

The first record of the use of cannon and gunpowder in Indian warfare is in the memoirs of Baber. In 1528 he forced the passage of the Ganges near Kanauj with the aid of artillery. For much valuable information on the subject of the early Asiatic fire-weapons the reader may consult an exhaustive article by Maj. Gen. R. MacLagan in the "Journ. As. Soc., Bengal," Vol. XLV. pp. 30 ff.

(1) 'La Chimie au moyen' âge, I. p. 94.

is conspicuous by its absence in the literature of the ancients. Niturm (natron) was all along exclusively applied to carbonate of soda.<sup>1</sup>

### SALTPETRE.

It will thus be seen that there is much in common in the history of the word used for nitrate of potash both in the Sanskrit and in the Latin languages, as in the former "sauvarchala" and "yavakshāra" are indiscriminately applied to it.

It is very remarkable that in the later Sanskrit chemico-medical literature the very word sauvarchala, which stands for saltpetre in the Sukranīti and in the Rasārnava, ceases altogether to be applied to it, but is used as a synonym of sārjikā (natron), while yavakshāra has been pressed into service, it being clean forgotten that from the time of Charaka and Susruta this word has been used

(1) Cf. "C'est par erreur que la plupart des éditeurs des auteurs grecs ou latins traduisent ces mots par nitre ou salpêtre, substance presque inconnue dans l'antiquité, et que apparaît seulement à partir du VI<sup>e</sup> siècle à Constantinople, avec le feu grégeois dont elle était la base. Les anciens parlent aussi du nitrum factice, préparé avec es cendres de chêne, c'est-à-dire du carbonate de potasse."—"Intro la l'étude de la Chimie," p. 263.

in its radical sense, *viz.*, the *ashes of barley* (impure carbonate of potash, from yava, barley and kshāra, ashes). Both Wilson and Monier Williams in their Sanskrit-English Dictionaries, following no doubt the authority of modern writers, erroneously render yavakhāra as saltpetre as also does Colebrooke in his "Amarakosha". Roth and Böhtlingk in their Wörterbuch, however, correctly translate it as "Aetzkali, aus der Asche von Gerstenstroh."<sup>1</sup>

It is strange indeed that a substance which occurs extensively in Bengal and in upper India as an efflorescence on the soil should have been allowed to go without a definite name for several centuries.<sup>2</sup> Dutt says "nitre was unknown to the ancient Hindus. There is no recognised name for it in Sanskrit."<sup>3</sup> \* \* \* Some recent Sanskrit

(1) In the chemistry of Bubacar, "le sel de cendres" is the equivalent of yavakshāra—"La Chimie au moyen âge," 1. 308.

(2) We purposely use the words "allowed to go without a definite name," for the term *sauvarchala* was all along vaguely used now for saltpetre, now for natron.

(3) He is in error on this point, as he had not consulted, or probably had no acquaintance with, the old literature on the subject. Prof. Macdonell very properly points out "the dangers of the *argumentum ex silentio* [as] furnished by the fact that salt, the most necessary of minerals, is never once mentioned in the *Rig-*

formulas for the preparation of mineral acids containing nitre mention this salt under the name of "soraka". This word, however, is not met with in any Sanskrit dictionary and is evidently sanskritized from the vernacular *sorā*, a term of foreign origin. The manufacture of nitre was therefore most probably introduced into India after the adoption of gunpowder as an implement of warfare." <sup>1</sup> Mat. Med. of the Hindus, pp. 89-90, ed. 1900.

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veda. And yet the northern Panjāb is the very part of India where it most abounds. It occurs in the salt range between the Indus and the Jhelum in such quantities that the Greek companions of Alexander according to Strabo, asserted the supply to be sufficient for the wants of the whole of India." It would be equally hazardous to rush to the conclusion that nitre was "unknown" to the Hindus.

(1) Dutt is probably correct in so far as he states his views with regard to "the manufacture of nitre" as an ingredient of gunpowder. For it is well known saltpetre has been in use from time immemorial as the basis of rocket and other fireworks both in China and India. In the *Dasakumāracharita* by Dandī, mention is made of *yogavartikā* (magic wick) and *yagachūrṇa* (magic powder), of which saltpetre was probably the basis. The earliest account of the manufacture of saltpetre on a commercial scale that we have come across occurs in a rare work entitled: "The Travels of John Albert de Mandelso from Persia into the East Indies. London, 1669." The book is in the valuable collection of my friend, Mr. Prithvīa Chandra Rāya. Says our author:—

## MINERAL ACIDS.

Geber was up till recently credited with being the discoverer of nitric acid, aqua regia, silver nitrate &c. A careful examination of the works of Geber, both real and pretended, notably of the celebrated *Summa perfectionis magisterii*, has convinced M. Berthelot that the knowledge of the mineral acids was unknown not only to the Arabs but also to the European alchemists of the thirteenth century. It was a Latin author of the latter half of the 13th century who wrote the above memorable work and assumed the

“ Most of the *saltpeter* which is sold in *Gusuratta* comes from *Ajmer*, sixty Leagues from *Agra*, and they get it out of Land that hath lain long fallow. The blackest and fattest ground yields most of it, though other Lands afford some, and it is made thus : they make certain trenches which they fill with their Saltpetrous Earth, and let into them small Rivulets, as much water as will serve for its soaking, which may be the more effectually done, they make use of their feet, treading it till it becomes a Broath. When the Water hath drawn out all the salt-peter which was in the Earth, they take the clearest part of it, and dispose it into another Trench, where it grows thick, and then they boil it like salt, continually scumming it, and then they put it into earthen pots, wherein the remainder of the Dregs goes to the bottom ; and when the water begins to thicken, they take it out of these pots, to set it a-drying in the sun, where it grows hard, and is reduced into that form wherein it is brought into *Europe*.” pp. 66-67.

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venerable name of Geber to gain public confidence.<sup>1</sup> Such instances of literary forgery are by no means uncommon in the alchemical literature of the East and the West.

The distillation of alum is referred to in *Rasār-  
nava* and of green vitriol in *R.R.S.* (see pp. 71, 92) We have, however, no evidence that the acid thus derived was ever used as a solvent. Hoefer justly remarks that real progress in chemistry was impossible in India and China, as the preparation of mineral acids was unknown in both these countries.<sup>2</sup> At the same time we should remember that *Rasār-  
nava* and similar other works lay stress upon *viḍa*, in which aqua regia may be said to be potentially present and which is fitly described as capable of "killing all the metals" (see p. 72)

The preparation of mineral acids is incidentally described in several exclusively medical works, composed probably in the 16th and 17th centuries, *e. g.* "*Rasakaumudī*" by Mādhava, *Rasaratnapradīpa*, and "*Bhaishajyaratnāvalī*" by Govindadāsa, &c. In

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(1) "L'hypothèse la plus vraisemblable à mes yeux, c'est qu'un auteur latin, resté inconnu, a écrit ce livre dans la seconde moitié du XIIIe. siècle, et l'a mis sous le patronage du nom vénéré de Géber." "*La Chimie au moyen âge*," 1. 349.

(2) "*Hist. de la Chimie*," T. I. p. 25, ed. 1866.

the last work under the heading of mahādrāvakarasa, directions are given for distilling a mixture of among other things, alum, green vitriol, salammoniac saltpetre and borax in a glass retort. In this way a dilute solution of nitro-muriatic acid is obtained, which is prescribed in derangement of liver and spleen. We have a similar recipe in which in addition to the above ingredients, rock-salt and sea-salt are used, thus yielding what is called "samkhadrāvaka" (lit. solvent for conch-shell.)

The term "drāvaka" (solvent) seems to have been expressly coined to do duty for the mineral acids. We have seen all along that in the older works drāvaka was used invariably in the sense of solvent or flux (see p. 130) but never in the sense of a mineral acid, the knowledge of which seems to have spread both in the East and the West almost simultaneously. The regular application of the mineral acids to technical operations dates from the time of the Emperor Akbar or perhaps a little earlier. Thus in the *A'in-i-Akbari* under the "Method of Refining Silver" mention is made of the use of *rasi* (aqua fortis). It is not easy to make out how much of the processes of the assay of gold and silver as described in the *A'in* is of Hindu origin.

Royle, Sir W. O'Shaughnessy ("Manual of

Chemistry"), Ainslie and others maintained that the Hindus were acquainted with the methods of preparing the mineral acids. These authors who wrote more than half-a-century ago derived their information at second-hand as none of them had probably read the Sankrit works in the original. Ainslie gives the following recipes as used in Southern India among the Tāmil physicians for the preparation of sulphuric, nitric and muriatic acids respectively :

Sulphuric acid : " The Tāmil physicians prepared their article nearly in the same way that we do, *vis.*, by burning sulphur with a small with a small piece of nitre in strong earthen vessels."

O'Shaughnessy says : " sulphuric acid, the *Gundak kā āttar* of the Hindus has long been known among the Eastern nations. In southern India it has been prepared for many centuries."

Nitric acid : This acid the Hindus make a clumsy attempt at preparing in the following manner which must not be rigidly criticised by the chemists of Europe.

|                                                                       |           |
|-----------------------------------------------------------------------|-----------|
| Take of saltpetre                                                     | 20 parts. |
| „ alum                                                                | 16 „      |
| „ the acid liquid from the leaves and stem<br>of the Bengal horsegram | 18 „      |

Mix and distil with an increasing heat till the whole of the acid is condensed in a receiver.

Muriatic acid : 'Take of

common salt                   ,,   8 parts

alum                           ,,   6 parts

The acid liquid from the horse gram and distil &c."

The very name of sulphuric acid, *Gundak ká áttar* is Urdu *i.e.* the hybrid *lingua franca*, an admixture of Hindi with Persian. *Attar* in Persian means the volatile principle, often odoriferous, *e.g.* *Guláb ká áttar i.e.* otto de Rose. "Gundhak" in Sanskrit is the equivalent for sulphur.

# Knowledge of Technical Arts

## AND

# Decline of Scientific Spirit

In ancient India the useful arts and sciences, as distinguished from mere handicrafts, were cultivated by the higher classes. In the White Yajur-Veda and in the Taittirīya Brāhmaṇa, we meet with the names of various professions which throw light on the state of society of that period ; unfortunately a knowledge of these perished with the institution of the caste system in its most rigid form. <sup>1</sup> Among the sixty-four “kalās” or arts and sciences which are enumerated in the old work of Vātsāyana <sup>2</sup> called Kāmasūtra occur the names of the following :

(1) See Dutt's “ Civilization in Ancient India,” pp. 155-157, Calcutta ed.

(2) “Vātsāyana is another old authority.....The name occurs in Pāṇini 4. 1. 73. and probably the author of the Kāmasūtras was meant as some of his rules refer to terms chiefly used in the latter. The text has come down to us almost undefiled, showing its great popularity among our ancestors, which is also clear from its commentaries and reference by Dandī, Vāmana and other great writers.”—Preface to Barua's “Amarakosha,” preface, xiii.

सुवर्णरत्नपरीक्षा :—or the examination and valuation of gold and gems.

धातुवादः or chemistry and metallurgy.

रत्नवर्णरागाकरज्ञानम् : :—or knowledge of the colouring of gems and jewels, as also of mines and quarries.

In the Sukranītisāra or the Elements of Polity by Sukrāchārya, we also read an account of the various “kalās” : *e.g.*

पाषाणधात्वादिदृष्टिसदृशोत्करणं कला :—“the art of piercing and incinerating the stones and the metals is known as a “kalā.”

धातुयौषधीनां संयोगक्रियाज्ञानं कला स्मृता : :—“a knowledge of the combinations of the metals and the herbs and the plants is also regarded as a “kalā.”

धातुसंयुक्त्यर्थव्यकरणं कला स्मृता ।

संयोगापूर्वविज्ञानं धात्वादीनां कला स्मृता ॥

“The art of alloying and separating the metals is also known as a “kalā.”

आरनिष्कासनज्ञानं कलासंज्ञं तत् स्मृतम् ।

कलादश्चकमेतच्च आयुर्वेदागमेषु च ॥

“The art of extracting alkali (see pp. 31-38 under Susruta) is likewise counted as a “kalā”. In the science of Āyurveda, there are altogether ten “kalās”.

We also find that among the companions of the poet Vāna were an assayer and a metallurgist.<sup>1</sup> Such terms as "lohavid" and "dhātuvid" which occur repeatedly in Sanskrit literature show that the metallurgists were held in high esteem and expert knowledge sought after.

The art of dyeing was carried almost to perfection, the fast colours resembling the Tyrean purple.

In the Vedic age the *Rishis* or priests did not form an exclusive caste of their own but followed different professions according to their convenience or natural tastes, thus fulfilling the ideal laid down by Emerson : "Has he (man) not a *calling* in his character? Each man has his own vocation. The talent is the call." But all this was changed when the Brāhmins reasserted their supremacy on the decline or the expulsion of Buddhism.

The caste system was established *de novo* in a more rigid form. The drift of *Manu* and of the later *Purānas* is in the direction of glorifying the priestly class, which set up most arrogant and outrageous pretensions. According to *Susruta*, the dissection of dead bodies is a *sine quā non* to the student of surgery and this high authority lays par-

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(1) Cowell and Thoma's Trans. of *Harsha-charita*, p. 33.

cular stress on knowledge gained from experiment and observation. <sup>1</sup> But Manu would have none of it. The very touch of a corpse, according to Manu, is enough to bring contamination to the sacred person of Brāhmin.<sup>2</sup> Thus we find that shortly after the time of Vāgbhata, the handling of a lancet was discouraged and Anatomy and Surgery fell into disuse and became to all intents and purposes lost sciences to the Hindus. It was considered equally undignified to sweat away at the forge like a Cyclops. Hence the cultivation of the *kalās* by the more refined classes of the society of which we get such vivid pictures in the ancient Sanskrit literature

(1) त्वक्पञ्चस्तस्य देहस्य योऽयमङ्गवि निश्चयः ।

शल्यज्ञानाद्वृत्ते नैव वर्ण्यतेऽङ्गेषु केषुचित् ॥

तस्मान्निःशयं ज्ञानं हृत्वा शल्यस्य वाञ्छता ।

शोधयित्वा स्मृतं सम्यग् दृष्टव्योऽङ्गविनिश्चयः ॥

प्रत्यक्षतो हि यददृष्टं शास्त्रे दृष्टं च यद्विदितम् ।

समासतस्तुभयं भूयो ज्ञानविवर्द्धनम् ॥ 43-45

\* \* \* \* \*

शरीरे चैव शास्त्रे च दृष्टार्थः स्याद्विशारदः ।

दृष्टव्युताभ्यां सन्देहमवापोह्याचरेत् क्रियाः ॥ 48

Sārīra. Ch. V.

(2) The "Laws of Manu," V. 64, 85, 87.

has survived only in traditions since a very long time past.<sup>1</sup>

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(1) Similar dangers have threatened Europe from time to time but her sturdy sons have proved better of them in the long run. Thus "Aristotle's opinion that 'industrial work tends to lower the the standard of thought' was certainly of influence here. In accordance with this dictum the educated Greeks held aloof from the observation and practice of technical chemical processes; a theoretical explanation of the reactions involved in these lay outside their circle of interest."—Meyer's "Hist. of Chemistry," trans. by McGowan, p. 10, ed. 1893.

Paracelsus flings a sneer at the physicians of his time and compares them with the alchemists in the following terms: "For they are not given to idleness nor go in a proud habit, or plush and velvet garments, often showing their rings upon their fingers or wearing swords with silver hilts by their sides, or fine and gay gloves upon their hands, but diligently follow their labours, sweating whole days and nights by their furnaces. They do not spend their time abroad for recreations but take delight in their laboratory. They wear leather garments with a pouch, and an apron wherewith they wipe their hands. They put their fingers amongst coals, into clay, and filth, not into gold rings. They are sooty and black like smiths and colliers, and do not pride themselves upon clean and beautiful faces."—Quoted by Rodwell in his "Birth of Chemistry."

Even so late as the middle of the last century, the pursuit of Chemistry in England was not regarded in a serious light and "chemists were ashamed to call themselves so because the apothecaries had appropriated the name"—a circumstance which led Liebig in 1837 to declare "that England was not the land of science."

The arts being thus relegated to the low castes and the professions made hereditary, a certain degree of fineness, delicacy and deftness in manipulation was no doubt secured but this was done at a terrible cost. The intellectual portion of the community being thus withdrawn from active participation in the arts, the *how and why* of phenomena—the coördination of cause and effect—were lost sight of—the spirit of enquiry gradually died out among a nation naturally prone to speculation and metaphysical subtleties and India for once bade adieu to experimental and inductive sciences.<sup>1</sup> Her soil was rendered morally unfit for the birth of a Boyle, a Des Cartes or a Newton and her very name was

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(1) The Vadánta philosophy, as modified and expanded by *Samkara*, which teaches the unreality of the material world, is also to a large extent responsible for bringing the study of physical science into disrepute. *Samkara* is unsparing in his strictures on *Kanúda* and his system. One or two extracts from *Samkara's* Commentary on the *Vedánta Sútras*, will make the point clear :

“तस्मादेवमसारतरतर्कसंहृत्यत्वात्, ईश्वरकारणव्यतिरिक्तत्वात्, श्रुतिप्रव-  
क्षेयं शिष्टेर्भगवादिभिरपरिगृहीतत्वात्, अत्यन्तमेवाऽनपेक्ष्यमाणं परमाद्युक्ता-  
रणवादे कार्यार्थऽर्थः श्रुत्योऽर्थेभिरिति वाक्यशेषः । १।१।१० सूत्रभाष्यम् ।  
वैशेषिकराज्ञानो दुर्युक्तियोगाद् वेदविरोधात्, शिष्टपरिवृत्त्या नपेक्षितम्  
इत्युक्तं सोऽर्हवेनाशिक इति वेनाशिकत्वस्यात् सर्ववेनाशिक-राज्ञानो  
नितरासनपेक्ष्यव्य इतीदं ईदानीं उपपादयामः । १।१।१८ सूत्रभाष्यम् ।  
“Vedánta Darsana,” Bombay ed.

all but expunged from the map of the scientific world.<sup>1</sup>

In this land of intellectual torpor and stagnation the artizan classes, left very much to themselves and guided solely by their mother wit and sound commonsense, which is their only heritage in this

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"It thus appears that the atomic doctrine is supposed by very weak arguments only, is opposed to those scriptural passages which declare the Lord to be the general cause, and is not accepted by any of the authorities taking their stand on scripture, such as Manu and others. Hence it is to be altogether disregarded by high-minded men who have a regard for their own spiritual welfare." II. 2, 17

"The reasons on account of which the doctrine of the Vaiseshikas cannot be accepted have been stated above. That doctrine may be called semi-destructive (or semi-nihilistic)." Thibaut's trans., *Ibid.* 18.

(1) Among a people ridden by caste and hide-bound by the authorities and injunctions of the Vedas, Puranas, and Smritis and having their intellect thus cramped and paralysed, no Boyle could arise to lay down such sound principles for guidance as :

P. XXVI. "... I saw that several chymists had, by a laudable diligence obtain'd various productions, hit upon many more phenomena, considerable in their kind, than could well be expected from their narrow principles : but finding the generality of those addicted to chymistry, to have had scarce any view, but to the preparation of medicines, or to the improving of metals, I was tempted to consider the art, not as a physician or an alchemist, but a philosopher. And, with this view, I once drew up a scheme

world, have kept up the old traditions.<sup>1</sup> In their own way they display marvellous skill in damascening, making ornamental designs on metals, carving on ivory, enamelling, weaving, dyeing lace-making, goldsmith's and jeweller's works, etc.<sup>2</sup>

The successive stages in the manipulation of one branch of the arts have been carefully watched by Mr. Jñānasarāṇa Chakravartī M. A., late Scholar, Presidency College, and his experiences embodied in a paper, which, for the most part, is reproduced below with certain alterations; it is of singular interest as a contribution to the history of the Indian technical arts. It now remains only to add that some of the processes described below were in

for a chymical philosophy; which I shou'd be glad that any experiments or observations of mine might any way contribute to complete.'

P. XVIII. "... And, truly, if men were willing to regard the advancement of philosophy, more than their own reputations, it were easy to make them sensible, that one of the most considerable services they could do the world is, to set themselves diligently to make experiments, and collect observations, without attempting to establish theories upon them, before they have taken notice of all the phenomena that are to be solved." Shaw's ed. of Boyle's works, 3 vols. 1725.

(1) Vide manufacture of alum, pp. 147-51.

(2) For detailed information on some of these branches the reader may consult Birdwood's Industrial "Arts of India".

vogue at the time of the Emperor Akbar and probably existed long before, as Rasārnava amply testifies (p. 68). The very terms "*poonoor*" (*pun-hār*) and "Neharwalla" (Niāriyah) occur in the descriptions of the assay of gold in *Āin-i-Akbari*.<sup>1</sup>

### **The wastage of Gold in the course of Preparing Jewelry in Bengal<sup>2</sup>**

#### **SOLDERING**

The next process that we shall consider is soldering. This is undoubtedly the most important process that the goldsmith has to perform from a commercial point of view. It is in the course of this process that the practical goldsmith plays those

(1) Along with Mr. Chakravart's Essay should be read *Āins* 7, 8 and 9 "on the Manner of Refining Gold," "the Method of Refining Silver" "and the Method of Separating the Silver from the Gold," Blochamann's trans. Vol. 1. pp. 20-25.

(2) "Indian Engineering." XIX (1895). The Mechanical Operations of Melting and Hammering have been left out.

mischievous tricks which go so hard against those who purchase his productions or order for them. The quality or quantity of solder (or *pān*) employed is the first question that is universally enquired into in all cases of commercial dealings in Indian jewelry; and while by melting some articles the value of the gold per tola is reduced by Re. 1 or 2 only, we frequently find cases in which the value is decreased at the ruinous rate of Rs. 8 or Rs. 10. This last state of affairs arises when the solder consists almost entirely of a mixture of baser metals and is at the same time fraudulently used in larger quantities than what is absolutely necessary.

Considered, however, from the standpoint of a chemical student who investigates the subject of ascertaining the amount of metal that is lost in the operations of the goldsmith, the process of soldering is scarcely important enough to receive a separate treatment. The preparation of the solder and its reduction to the condition of small thin bits are embraced in the discussion of melting and hammering; while the loss during the blowing operation, during which the reducing flame of an oil lamp is made to play upon the solder and the parts it is meant to join together, may be supposed

to have been treated during the discussion of the subject of loss of gold by volatilisation. The fact that almost all solders contain a little zinc perhaps makes the loss in their case to be much greater than in that of an alloy of gold and copper only. The following three sets of figures give the weight of gold and the weight of solder before the process of soldering and the weight of the article after the operation has been finished :—

| Gold  |       |       | Solder |       |       | Wt. of Gold & Solder<br>after operation. |       |      |
|-------|-------|-------|--------|-------|-------|------------------------------------------|-------|------|
| Tolas | annas | pies. | Tolas  | annas | pies. | Tolas                                    | annas | pies |
| 6     | 0     | 0     | 1      | 0     | 0     | 6                                        | 15    | 0    |
| 2     | 0     | 0     | 0      | 8     | 0     | 2                                        | 7     | 13/4 |
| 3     | 8     | 0     | 1      | 4     | 0     | 4                                        | 10    | 3    |

Thus, on the whole a loss of  $11\frac{1}{4}$  pies takes place in dealing with  $14\frac{1}{4}$  tolas of materials. This gives the rate of loss at 79 pies per tola.

It is proper to observe that of the loss that takes place during soldering, about one-third is due to purely physical causes, *e. g.* the loss of pieces of solder which fly off before the blowpipe. The above figures are accordingly not to be supposed as affording an accurate estimate of the amount of material that is lost by vapourisation during the operation of soldering.

## FILING AND CUTTING

These are the two operations of the goldsmith in the course of which gold is lost to an appreciable extent. The work of cutting is done by a class of men called *nakāshiwalās* to whom the articles are made over for the purpose. In recognition of the fact that loss of gold must inevitably take place during the operation of cutting, the goldsmith, when he takes back the articles and the particles that are chopped off the surface from the *nakāshiwalās*, generally makes an allowance of one pie per tola in favour of the latter.

The loss which takes place during the operation of cutting as well as the loss during filing, *i.e.* rubbing the surface of gold with a steel file to make it smooth, is due to causes of a purely mechanical nature and can be prevented to a great extent by the means suggested for minimising such loss in the course of hammering and drawing.

The operation of cutting is always, and that of filing some times, effected after the article has been coloured and polished. But as the chemical process of colouring will be treated of separately in the following pages, the mere mechanical operation

of cutting and filing are here put in for the purpose of preserving continuity.

#### THE CHEMICAL OPERATIONS OF THE GOLDSMITH : CLEANSING, COLOURING AND POLISHING

We now come to a process which, though not so important in the eyes of the goldsmith as some of the processes before described, is yet of the greatest consequence in the enquiry in which we are engaged. This is the process of colouring.

If it were possible for our goldsmiths to work with pure gold, the appearance of the material would suffer very little by the various processes of heating, hammering, &c., and a mere mechanical rubbing would throw off the superficial dirt and be sufficient to expose the natural yellow surface of the unalloyed metal. This property of pure gold is due to the fact that no oxides of gold are formed at temperatures to which the metal is exposed during the operations of the goldsmith. Indeed it is well-known that gold does not unite with oxygen at any temperature.

But the case is different with copper, the oxide of which is formed at temperatures which are ordinarily attained by the goldsmith in the course of his operations. Hence, if a mass of copper is

heated in the goldsmith's fire, it is divested of its bright red colour and acquires a dirty black appearance due to the formation of a coating of cupric oxide. Now, an alloy is nothing but an intimate mechanical mixture of its constituent metals—the molecules of the several metals lying promiscuously as it were. In an alloy of gold accordingly in which copper forms a constituent part, the particles of the latter are freely interspersed between those of gold. When such a substance is heated in air, the gold particles retain their primitive yellow, but the particles of copper, which are exposed to air, are oxidised into  $\text{CuO}$ . This substance is, as we know, a black amorphous powder and it gives to the whole mass a black appearance, which becomes darker as the metal is hammered over and the powder is thoroughly spread over the surface of the metal.

An interesting and rather curious experiment clearly illustrates the above explanation. If a piece of gold containing a little copper be heated in air and care be taken not to rub the metal in any way so as to spread the black oxide of copper over the surface, it will be found that the metal, if free from external dirt or soot, will be still yellow and tolerably bright. The yellow of the more numerous gold particles overpowers the colour of the black

oxide of copper. If, however, this black substance be spread over the surface of the metal, the colour instantly changes. The spreading of the oxide is easily brought about by hammering, and thus we can take an apparently bright piece of metal and, by hammering reduce it to a jet black mass.

The ignorant goldsmiths explain this blackening by supposing the stain of the black steel hammer to adhere to the surface of gold.

We may, perhaps, in this connection mention a particular artifice which is sometimes employed by our goldsmiths to cleanse the surface of a gold and copper alloy, which has been blackened by fire. This method is employed whenever it is desirable in the course of working to expose the bright surface, but where it would be inconvenient, impossible or unnecessary to apply the long and laborious mode of cleansing or colouring which we shall hereafter describe. It is found that if a blackened piece of gold and copper alloy be heated in a charcoal fire to redness and then water be sprinkled on the fire, the alloy at once acquires the bright colour of gold. This phenomenon, though often practised by our goldsmiths, is a puzzle to the most intelligent among them. \* \* \* \* \* The true explanation of the operation seems to be

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that, when placed in a charcoal fire, the cupric oxide is reduced to metallic copper. But if it is taken out when hot, it comes into contact with the air again and is oxidised. What the goldsmith does is to suddenly cool down the metal when in the reduced state and not to allow it to come into contact with the open air, until it has cooled sufficiently down, so as not to be liable to re-oxidisation.

From what has been stated above, it will be easily seen that when a piece of golden ornament has been completed by the manufacturer, it is of a dirty dark colour and must be cleansed before it can be used. In this country mere cleansing is not sufficient, for the popular taste does not approve the new golden articles appearing and being used in the yellow colour of true gold. The articles must be "coloured" before they can be made over to the customer, by which is meant that a bright reddish colour must be imparted to them. The particular tinge which is liked by different persons is different, some people liking a colour verging very nearly on red or orange, while others have a fancy for a colour which approaches to reddish violet.

The process of imparting the requisite shade of colour to articles of gold is one of the most

cumbrous and complicated chemical operations in the whole range of indigenous arts and manufactures of India. The numerous chemical reactions that take place in the several stages of the business are of more than ordinary interest; while the immense loss of gold that apparently takes place leads one to wonder why the subject has not as yet been taken up seriously by commercial or scientific men.

The process of colouring, so recently as 20 years ago, was universally carried out by the goldsmiths themselves, and in the villages and smaller towns the state of affairs is still the same. But in the metropolis and at the bigger stations of the province, the advantages of the principle of division of labour have lately begun to be felt in every branch of art and manufacture, and the result, so far as this particular subject is concerned, has been the springing up of a class of people whose sole business is to colour ornaments and other articles of gold. These men are known among our goldsmiths as the *rungwalas*. They do not charge any remuneration for their labour, but retain the fluid in which, during the process of colouring, a quantity of gold is dissolved.

We will now follow the *rungwala* through the course of a complete set of processès for colouring,

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skipping over the mere mechanical parts of the work, but dealing a little fully with the portions which are of a chemical nature.

### THE PROCESSES OF THE RUNGWALA

The shop of a Calcutta *rungwala* is one of the most miserably furnished working-places in the whole metropolis. A charcoal fire, a pair of bellows, a few crude pieces of indigenous earthenware, two or three coarse pots of China, together with a few other little things, are all that greet the eager sight of the observer whom business or curiosity leads to his dark and ill-ventilated den.

The *rungwala* has to wait till a sufficient number of golden articles are accumulated in his hands. He does not generally commence the process until he has got at least ten tolas of gold for colouring. Because the cost, the trouble and the time required, as he says, in going through a complete series of operations are such as to prohibit his doing the work with a smaller amount of gold at a time. Ordinarily a "khola", as the amount of gold coloured at one operation is called, consists of about 20 to 30 tolas of gold.

Having got the amount of gold sufficient for working a *khola*, the first thing that the *rungwala*

has to do is to cleanse the articles of all external dirt as well as of the blackness due to the formation of  $\text{CuO}$ . With this view he first heats them in a charcoal fire, thus causing all the oil, charcoal dust, and other foreign substances on the surface to burn off. He next puts an earthen vessel on his fire and boils in it about a seer of the unripe fruit of tamarind (*Tamarindus Indica*), a substance containing considerable amount of tartaric and other acids in the free state. Taking out these boiled articles and squeezing them so as to extract the extremely acid pulp he forms a thick syrupy fluid. In this fluid he boils the articles till the dilute acids dissolve away the cupric oxide, leaving a yellow surface of pure gold. It is found that the solution of tamarind pulp becomes distinctly blue in virtue of the formation of copper salts.

In the place of this rather clumsy mode of cleansing, which is largely practised even in the metropolis, some of the more adventurous *runghwalas* use a rather more clever and neater method. Instead of preparing a large amount of tamarind pulp they obtain from the grocer's an ounce or two of a dull white crystalline substance which they call "acid," and a solution of this serves equally well, if not better, for their purpose. To the question

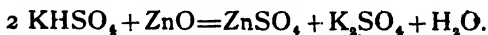
as to what the substance called "acid is, they cannot give a satisfactory reply. And even the grocer who sells it cannot enlighten the inquirer more than to this extent that the article is a *gāḍ* (scum) or a bye-product in the manufacture of some acid. Having subjected the substance to a rough chemical analysis, we came to the conclusion that the substance should be nothing more nor less than  $\text{KHSO}_4$  or hydric potassic sulphate, an acid salt and a bye-product, as we know, in the process of manufacturing nitric acid. The reaction of this substance on the copper seems to be this:—



The normal salt di-potassic sulphate, copper sulphate and water are formed.

What takes place in the gold as regards the particles of copper takes place also in the solder used as regards the particles of both zinc and copper that are on the surface.

The oxides of copper and zinc are acted on by the dilute acids of the tamarind or the hydric potassic sulphate as the case may be, and are dissolved away in the form of soluble salts. The reaction in the latter case is:—



As the solder contains a large amount of silver,

its appearance after the copper and zinc have been dissolved away, is almost perfectly white, which appears rather prominent by the side of the bright yellow surface of gold.

The next operation of the *rungwala* is perhaps intended to carry on the operation of cleansing to a further extent. He takes about half a pound of common salt, and mixes it with an equal amount of ordinary potash alum, purchased from the bazar.

The mixture is then reduced to the form of a fine paste. The *rungwala* now covers each of the articles to be coloured with a thin layer of this paste of salt and alum and then places them on the fire. After the paste has dried up it is washed off with water, and generally the colour of the gold appears a little bit improved. The reason of this lies in the fact that the few particles of cupric oxide that remain on the surface are not wholly dissolved out by dilute acid in the first operation are got rid of by this process.

After having been subjected to these two processes, the article acquires almost perfectly the beautiful yellow of pure gold; but as has been stated already the *pān* or solder appears at the same time as white as pure silver. The contrast of these two different colours placed in close con-

tiguity is rather marked; and the next operation of the *rungwala* is intended to remedy this defect. In order to make the solder and the metal appear of the same colour, he actually covers the surface of the solder with a layer of gold taken from the article itself. This is done in the course of the third process, which we will describe rather fully, as it is the most important of these stages of manipulation at which loss of gold takes place in considerable amount.

Having placed an open earthen vessel on his fire and having put some water in it, the *rungwala* prepares a mixture consisting of, about four parts of nitre (say 1 lb.), one part of common salt and 1 part of alum (say  $\frac{1}{4}$  lb each).<sup>1</sup> He then puts the mixture into the vessel, taking care always that the water in the vessel be not more than what is necessary for dissolving about half the amount of salts added. The solution is then heated till it boils evolving large quantities of gases and fumes, amongst which chlorine can be easily detected by its unmistakable corroding odour.

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(1) Cf. p. 73 under "killing of mercury and gold," where a mixture, among other ingredients, of alum, common salt and saltpetre technically called a *vida*, is used.

In this boiling solution the goldsmith places the cleansed ornaments so as to keep them wholly immersed. He examines them from time to time and after a while finds that a layer of shining gold has formed on the surface of the white solder. When this deposit is sufficiently thick and the whole article presents the appearance of being formed out of a homogeneous material he takes them out and, washing them well, prepares them for the next operation.

#### CHEMICAL EXPLANATION

It is difficult to find out exactly the series of chemical reactions that take place during this period. Various impurities in the articles employed make the inquiry doubly complicated. It would, however, do for our purpose to investigate briefly the principal decompositions and formations that occur, and with this view we may suppose the reagents employed to be chemically free from foreign substances.

It is well-known that if nitric and hydrochloric acids are brought together, certain reactions take place. If the acids be tolerably concentrated they act upon one another at ordinary temperatures, the mixture becoming yellow and giving off minute

bubbles of gas, smelling like chlorine. If the acids be dilute, we have to heat the mixture to bring about the chemical change. The action that takes place consists of two of stages :—

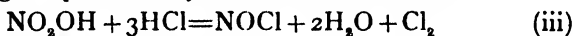
First, the oxygen from the nitric acid oxidizes the hydrogen of the hydrochloric acid, thus :—



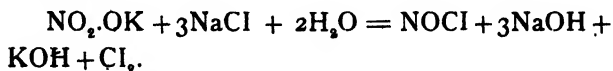
Secondly, the unstable nitrous acid that is formed acts on another molecule of HCl, producing a compound known as nitrosyl chloride and water, thus :—



The reactions (i) and (ii) when expressed by a single equation may be written as follows :—



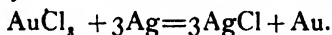
Now, here, instead of free nitric and hydrochloric acids, we have saturated solutions of a nitrate and a chloride, and an action similar to the above may take place under the influence of heat only, instead of water, the hydrates of the metals present in the nitrate and the chloride are formed. Thus, instead of equation (iii) we may have the following action :—



When the solution boils and these actions set

in, the *rungwala* puts the golden articles in it. The chlorine liberated as well as the chlorine in the nitrosyl chloride attacks the gold and reduces it to the form of a soluble chloride, which mixes with the mass of the fluid. The NO of the nitrosyl, which is liberated, is itself a colourless gas, but it rapidly unites with the oxygen of the air and forms the red fumes of nitrogen peroxide which, together with chlorine, are liberated in large quantities during the third stage of colouring.

Now we know that if a solution of gold chloride of sufficient strength is formed and a piece of silver is dipped into it, gold is deposited on the surface of the silver, while a portion of the silver is worn away. The reaction is as follows:—



This reaction takes place in connection with the surface of the solder which is exposed. A layer of gold is formed upon it entirely hiding the white surface, so that to all appearance the whole article seems to be composed of the same material.

In the explanation given above, the use of alum that is added to make up the *jamaḥ* (as the solution employed in the third stage described above is called) has not been shown, and indeed this point we have not been able to clear as satisfactorily as

perhaps it is capable of. <sup>1</sup> It seems to undergo no chemical change, and hence does not act in the capacity of a mordant in this case, as it does so widely in the arts of dyeing or calico printing. It is also found that if no alum is added to the *jamak*, the coating of gold on the solder is produced, but it adheres very lightly to the surface and does not stand such processes as rubbing or brushing. Hence it seems that the only function of the alum is to fix the coating, i. e. to make it adhere firmly to the surface of the solder. Experienced goldsmiths are also of opinion that, but for the alum, the gilding of the *pān* would not be permanent. The way in which this is done by the alum is to a certain extent a matter of conjecture. We suppose that the action is of a mere mechanical nature. When the particles of gold stick to the surface of the solder, small quantities of alum solution remain in the pores between the separate particles. These afterwards dry up and crystallise, and the minute crystals act as a sort of mortar

(1) Mr. Chakravarti all along fails to realise the important part which alum plays in yielding sulphuric acid. Moreover in the above equation chlorine cannot be expected to be set free in presence of alkalies; see below under "the Hindu method of manufacturing calomel."

between the particles of gold and the surface of the solder, as well as between the particles themselves.

The third process in the course of colouring is by far the most important source of loss of gold in the whole series of manipulations that the metal has to undergo. We have seen that the losses at all other stages are due to causes of a mere mechanical nature and are necessarily small. In all these cases, the gold escapes the vigilant eye of the worker and hence the extent to which it is lost sight of is minute indeed. Here for the first time the gold undergoes a chemical change—it ceases to exist as gold altogether—and is consequently lost for ever to the illiterate goldsmith.

We should remark that only a very small part of the gold that is dissolved out in the *jamak*—as the solution of nitre, alum and salt used in the third stage described above is called—is re-deposited on the surface of the solder. A large portion of the gold remains in the solution as  $\text{AuCl}_3$ ,  $\text{NaCl}$ ,  $2\text{H}_2\text{O}$ . The helpless *rungwala* can do nothing with his valuable fluid but dispose it off for a trifling sum to a class of men called *jamakwalas* who have a crude method of their own to extract some quantity of the gold from the *jamak*. We

shall return to the *jamakwala* subsequently. We must now proceed to the fourth or last stage of colouring, during which the requisite colour is imparted to the metal. The articles, after being extracted from the boiling *jamak* solution, are thoroughly washed and rubbed with a brush, after which another bath is prepared for them. This consists of a solution of tamarind pulp, nitre and common salt in water, which is placed in an earthen pot on fire and heated to ebullition. A little sulphur is then added after which the articles are placed in the liquid. The sulphur is added in a finely divided state, obtained by rubbing a stick of sulphur with a little water on a piece of slate. Care is always taken to add an insufficient amount of sulphur at first, for it is found that the shade of colour that is produced in the gold depends solely on the quantity of this ingredient, which accordingly requires exceedingly carefully regulation. The *rungwala* now examines the colour from time to time, adding more sulphur gradually if he wants the colour to deepen. When the requisite shade of colour is reached, he stops adding the sulphur and keeps on boiling for some time more, after which he takes the articles off the solution and gives them a final wash and polish. If too much

sulphur is added in this operation the colour becomes deep violet and finally black, and the whole process is vitiated. Under the circumstances the *rungwala* has to recommence the work from the very beginning.

It may be noticed that the acid or the commercial hydric potassic sulphate is never used in this stage, as it is used in the first, instead of the tamarind pulp. The reason seems to be that as nitre is also present in the mixture, the addition of  $\text{KHSO}_4$ , in the presence of other substances, may result in the formation of nitric acid under the influence of heat.

The chemical actions that take place during the fourth or last stage of colouring seems to be extremely difficult of explanation. There can be little doubt, however, as to the fact that the reddish violet colour is due to the deposition of a thin layer of some compound of gold on the surface of the articles. It is the determination of this compound and of the exact nature of the process by which it is formed that presents all the difficulty.

The fact that the sulphur is one of the most essential things that are required in the production of the colour would seem strongly to suggest at the first glance that the reddish violet tint is due

to the formation of one of the sulphides of gold. It appears that the subject and constitution of the compounds of gold and sulphur is one which has not yet been fully investigated by chemists. But it seems to be a well-established fact that no sulphide of gold is known which is of any other colour than black. This stands in the way of our accepting the hypothesis that the reddish violet colour of gold obtained by the Indian goldsmith is due to the formation of a layer of sulphide on the surface. From the fact that if the colouring is allowed to be overdone *i. e.* if the articles be boiled further after the required tint has been obtained, the gold acquires a deep violet colour, the same conclusion is arrived at.

Accordingly, in spite of the fact that the amount of sulphur added regulates the whole operation of the last stage of colouring, we are constrained to search for the reddish violet colour that is developed in the formation of some other compound than a sulphide. The nature of the colour being the same as would be produced by a thin layer of a violet substance on a yellow surface, it follows that the colour of the compound formed must be violet. And the fact that when the colour is overdone, *i. e.* when a thick layer of the coloured

substance is formed on the surface, the appearance of the metal is dark violet, abundantly confirms the hypothesis. The only compound of gold that possesses this characteristic colour being aurous oxide  $\text{Au}_2\text{O}$ , we are forced to the conclusion that the colour of gold is due to the formation of a thin layer of suboxide on the surface of the metal.

An examination into the nature of the chemical actions that take place during the operation clearly shows that  $\text{Au}_2\text{O}$  is the compound formed. We have seen in investigating the chemical changes during the third stage of colouring that  $\text{KNO}_3$  and  $\text{NaCl}$  being heated together, yield free chlorine together with  $\text{KOH}$  and  $\text{NaOH}$ . This chlorine after being liberated in the fourth stage attacks the gold and a small amount of auric chloride is formed. But at this point sulphur is added, and the nascent chlorine, instead of going to attack the gold any more, combines with the sulphur to form one or more of the sulphur chlorides. The supply of fresh chlorine being thus cut off, the heated auric chloride decomposes into aurous chloride and chlorine. The chlorine thus liberated combines with the sulphur, while the aurous chloride is acted on by the  $\text{KOH}$  and  $\text{NaOH}$  with the result that  $\text{Au}_2\text{O}$  is

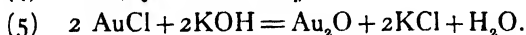
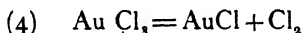
formed.<sup>1</sup> This is partly deposited on the surface of the gold producing the required colour and partly mixed with the saline solid matter present in the solution.

The series of chemical reactions may be expressed by formula as follows :—

(1)  $\text{KNO}_3 + 3\text{NaCl} + 2\text{H}_2\text{O} = \text{NOCl} + 3\text{NaOH} + \text{KOH} + \text{Cl}_2$ ; this reaction itself consists of two stages as explained before.



(3)  $2\text{Cl} + \text{S}_2 = \text{S}_2\text{Cl}_2$  ( $\text{S}_2\text{Cl}_2$  may also be formed in the presence of excess of nascent chlorine).



It will be observed from the above formula that the addition of sulphur is indispensable in this operation. If the excess of chlorine were not removed by sulphur, as is done in (3) above, the gold would continue to be dissolved out and a large loss of the metal would arise as in the course of the third stage.

Moreover, with a free supply of chlorine, the auric chloride would never be reduced to aurous chloride.

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(1) The explanation is scarcely satisfactory; it may be taken for what it is worth—

ride, and thus no formation of aurous oxide could take place. It is thus seen that, though the sulphur used is not directly contained in the compound which gives the colour, it regulates the whole reaction in the most important stages of its progress.

The above hypothesis is supported by the fact that if a little sulphur is added to the fluid obtained in the fourth stage of colouring, it will be found to dissolve in the fluid. This could not be the case unless a compound like  $S_2Cl_2$ , which can hold sulphur in solution, were formed during the re-action.

It has been mentioned above that the loss during the third operation of colouring is considerable. Indeed, from the records of observation given at the end of this section, it is clear that the loss is not only large, but that its extent is also uncertain in the extreme. In some cases it is as low as half a pie per tola, while in others it reaches the ruinous figure of six pies per tola, or nearly one tenth of the whole weight. The average amount of  $2\frac{1}{2}$  pies per tola, which is obtained from our figures, is not very different from the idea of experienced *rungwalas* and goldsmiths on the subject. The largeness and uncertainty of loss are easily accounted for by the ever-varying constitution of the bazar articles used in the operation, some of

them being very nearly pure, while others contain as much as 25 to 30 per cent of impurities, as well as by the want of any accurate precision as regards the proportion of materials employed. The ingredients are seldom weighed before being mixed together; and the varying amount of water present physically in the salts is an additional source of error and confusion in settling the proportion by mere inspection of bulk.

The following figures will give some idea as to the magnitude of the loss in colouring:—

| Weight before<br>colouring. |        |       | Weight after<br>colouring. |        |       | Loss. |
|-----------------------------|--------|-------|----------------------------|--------|-------|-------|
| Tolas.                      | Annas. | Pies. | Tolas.                     | Annas. | Pies. | Pies. |
| 6                           | 10     | 0     | 6                          | 7      | 15    | 105   |
| 3                           | 2      | 0     | 2                          | 14     | 1     | 15    |
| 12                          | 12     | 1     | 12                         | 5      | 3     | 26    |
| 5                           | 3      | 2     | 5                          | 2      | 0     | 6     |
| 3                           | 0      | 2     | 2                          | 12     | 0     | 18    |

### THE RESTORATIVE PROCESSES

Having in the previous paragraphs described with tolerable fulness the various sources of loss of gold in the course of its artistic manipulation by the Indian goldsmith and having in each case pointed out the form in which the metal escapes the hold of the worker, we will now turn our eyes to the meth-

ods which now obtain in our country for recovering, as far as possible, the amount of material which is lost. It is perhaps worth while here to point out that to re-obtain the entire amount of lost material is absolutely impossible from the innate property of the extreme divisibility of matter; and our sole object in these restorative operations should be to secure the recovering of the largest amount of metal that can possibly be saved. There are two small classes of men in Bengal who obtain their living by extracting gold from the refuse and bye-products of the goldsmith's workshop. These are the *neharwala* and the *jamakwala* before alluded to. These classes of men are found to cluster in the suburbs of large towns and important centres of jewelry manufactures. In the smaller towns and more insignificant villages, the bye-products have either to be thrown away or to be disposed of in the best manner that the goldsmith can hit upon. Not unfrequently in such cases the goldsmith himself undertakes to play the part of a *jamakwala* and *neharwala* to the best of his abilities. But the unpractised manipulation of processes, which are themselves far from being satisfactory is sure to result always in the loss of a large portion of gold.

We will now proceed to describe the operations

of the *neharwala* and the *jamakwala*. It may, however, be marked here that the immense difficulty in the way of obtaining the slightest information regarding the indigenous methods adopted by these workmen, in the exercise of their profession, can hardly be appreciated by one who has not personally made an attempt to penetrate into the mysteries of any of the trade or manufacturing secrets of India. The unfortunate stagnation of almost all departments of knowledge, art and industry in India that perplexes and mortifies an inquirer, owes its origin to a longstanding and universal spirit of conservatism inherent in our people which, however eloquently defended by orthodox advocates of caste, is manifestly one of the principal causes why the Indian craftsman lags so far behind in the modern race of nations. The healthy broadness of views, resulting from the dissemination of liberal English ideas among the masses, has, indeed, broken some of the most pernicious strongholds of the intellectual monopolies of India; but there are classes of men who still in obscure nooks of society keep to themselves what they regard as the treasures of professional secrets but what, after all, may be mere child's play to the eyes of the scientific world.

To our enquiries about the nature of the *neharwala* and the *jamakwala* the deafest ears were turned. Our attempts to impress upon these people the necessity of the application of chemistry to improve their methods were mere cries in the wilderness. And it was not until we had spent several weeks in constant intercourse with these people that we could begin to collect the information necessary for such an inquiry. Bit by bit we gained from different sources some knowledge of the processes which are given below in a continuous and well-arranged form.

### THE NEHARWALA

Now and then the *neharwala* makes his appearance in the goldsmith's workshop, in order to obtain the collected sweepings and other refuse of the rooms. The interval of time varies from one to three months according to the nature of the work that carried on in the rooms as well as to the amount of gold that is manufactured into ornaments. It is useful to state here that every day before work is commenced, the room is swept very clean and the sweepings, instead of being thrown away, are carefully stored up in a corner.

The heap of dust and rubbish thus accumulated from day to day is the chief object of the visit of the *neharwala*. Having inquired as to the amount of gold that has undergone manipulation since the last disposal of sweepings or *nehar* (from this the *neharwala* gets his name) as well as the nature of the articles that were manufactured, he proceeds to settle the price which depends chiefly on these conditions. The *nehar* of twenty tolas of good gold manufactured into articles, which required drawing, beating as well as soldering would generally be disposed of for a single rupee. It may be interesting to observe that a goldsmith, however dishonest in other respects, would never deceive a *neharwala* by selling to him a heap of ordinary rubbish for fear of losing credit and custom in the department of *nehar-selling*.

The next thing that the *neharwala* wants to obtain is the heap of rejected crucibles.

It has been stated before that indigenous crucibles cannot be employed more than once for melting purposes, and hence the number of waste crucibles is not small in our goldsmith's workshop. The nature of the crucibles and the amount of metal melted in each, together with the qualities of the gold, settle the price. We have seen a score of

crucibles of average size selling for eight annas.

If the goldsmith's shop is large, the soot hanging from the ceiling and walls is also purchased.

The last thing that the *neharwala* asks the shopkeeper is whether that day he would give a *taljhar*, by which is meant if he would allow the workmen's mats to be removed and shaken and the space below the mats swept. This operation is ordinarily performed once a year. The sweepings thus obtained are again valued. And after paying the prices the *neharwala* returns home with his heavy load, which sometimes reaches the respectable weight of 50 or 60 pounds.

The first thing that the *neharwala* does with his materials is to crush them fine. This is only necessary when earthen lumps of large size are formed and mixed up with the *nehar* in considerable numbers and is dispensed with in most cases where the large pieces are few in number and can be picked up and thrown away.

The second process is to throw the crushed materials into a big earthen pot in which the *nehar* remains immersed in water for a certain number of days, depending on the quality and quantity of the *nehar*. The object of this is to reduce fragments of clay to a fine state of division by which particles

of gold that might otherwise remain imbedded inside the mass of earthy lumps are at once exposed to view.

The next and the main operation is that of working. The thoroughly soaked *nehar* is put in large earthen vessels and more water is added if necessary. The mass is then thoroughly stirred and the lighter earthy material which yet floats when the heavy metallic matter has settled in the bottom, is taken off. By the repetition of this process the solid matter is reduced to a very small bulk. It is then allowed to settle and the water is slowly poured off. The moisture that yet remains is dried up either on fire or in the sun.

When several *nehars* have been separately washed in the preceding way, the remnants of all the washings are mixed together and the mixture is washed once again. This operation is exactly like the preceding but is carried on more carefully and in better vessels. When it has been completed, about one-quarter of the mixture may be perceived to consist of metallic substances.

Among the metals present in this mixture, iron is often found and, as its presence is extremely undesirable when the materials are placed on the crucible for melting, it is generally got rid of at this

stage. Formerly this was done by picking up the separate bits of iron by fine pincers, but now-a-days the magnet is almost universally used for the purpose.

The next process is that of melting. This is carried on in the ordinary way, care being taken to procure a crucible big enough for the purpose. The earthy matter sticks to the sides of the crucible, while the metallic portion melts and falls to the bottom. A mixture of gold, silver, copper and zinc is thus obtained.

The old method of obtaining pure gold from such a mixture as this is said to have been as curious and interesting as certainly it was laborious and protracted. The alloy was first of all beaten into leaves of extreme thinness, about 5 inches square in size. Each leaf was then covered with a thin layer of a paste of brick dust and common salt. The leaves were finally arranged one above another and exposed to the heat of fire. After a certain number of days, depending on the nature of the alloy and the temperature of the fire, the gold was found to be very nearly pure.

This method has now, however, been entirely superseded by the far easier and more economical process of treating the alloy with strong nitric acid.

For this purpose, however, the metal must be obtained in a fine state of division. This is done rather ingeniously by melting the material and, while molten, by suddenly dropping it in water. By this means the metal is at once reduced to a fine powder without the expenditure of any manual labour in the way of hammering. Care, however, should always be taken to see that the vessel of water in which the molten metal is dropped has a wide mouth. On one occasion, at which we were present, the liquid metal was poured into a narrow-mouthed vessel, and the steam suddenly generated was so great and powerful as to very nearly cause an explosion.

The extraction of gold from rejected crucibles is done much in the same fashion. These are pulverised and treated in the same way as ordinary *nehar*. Sometimes the powders of crucibles are mixed up with the common *nehar* to avoid the necessity of a separate series of operations, but more frequently the smallness of their bulk induces the *neharwala* to treat them separately.

### THE JAMAKWALA

We will now turn our attention to the methods of the *jamakwala*. He periodically visits the work-

shops of his patron, the *rungwala* from whom he obtains the necessary amount of *jamak* on the payment of a price which depends on the quality and the quantity of gold that has been coloured, as well as the loss of weight that has taken place in the articles during their make. To give an approximate idea of the commercial value of *jamak* it may suffice to state that we once purchased a *jamak* of 20 tolas of sovereign gold (which is 22 carats or 916.66 per mille fine) for one rupee only. We may also observe that the demand of *jamak* is not at present at par with the amount of its supply; and at some of the bigger *rungwala*'s working-rooms, one may see big earthen jars full of this substance, collected and stored up for want of purchasers. It may be interesting to add that even in this obscure department of business, the evil genius of man has set to work, and one has to be careful in dealing with a *jamakwala*, if one is a new hand in these affairs.<sup>1</sup> On one occasion we happened to be defrauded and were given a substance as a *jamak* of 35 tolas of gold for what

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(1) It may be observed, however, that a *rungwala* would never deceive a *jamakwala* in the same way as he would deceive a stranger for fear of losing credit and custom in the department of *jamak*-selling.

we considered the modest price of Rs. 2. But the thing turned out to be an imitation *jamak* only and all our best efforts could not discover in it the slightest trace of gold.

Having obtained a sufficient amount of this fluid the *jamakwala* returns home. His first step is to get rid of the fluid part of the *jamak* by boiling it. For this purpose he has got large earthen vessels with wide mouths which can be placed over a fire. When almost the whole amount of water has been evaporated off, he pours out the viscous mass into an open earthen vessel and proceeds to what we shall call the second process of the *jamakwala*.

With the solid matter of the *jamak* obtained by the first operation, the *jamakwala* mixes a small quantity of borax as well as a large amount of a substance known as *poonoor*. The weight of powdered *poonoor* that is thus added is about four times the weight of the *jamak* matter. Having thoroughly mixed these substances with such an amount of cow-dung as is required to give consistency to the material, he forms them into balls of about two or three inches in diameter. He then dries these balls and when perfectly dried they are ready for the third process.

The *poonoor* employed in the above process is a hard quasimetallic substance that can be purchased from certain grocers at the rate of three or four seers per rupee. It is, they say, nothing but a bye-product in the operation of *rupā-pākāno* by which is meant the operation of chemically purifying silver which has been alloyed with a large amount of copper and other metals. The usual method of conducting this operation in our country is to mix up the alloy with a large amount of lead and after melting the whole mass to blow air from above. [This operation, as also the next one, is practically that of cupellation]. The pure silver, it is found, separates in the course of the operation and collects at the bottom, while the partially oxidised lead, together with the impurities which existed originally in the silver constitutes the *poonoor* of trade. We analysed qualitatively a sample of ordinary bazar *poonoor* by the wet way after dissolving it in nitric acid and found it to contain lead, copper and zinc with traces of silver and iron.

The third process of the *jamakwala* is the main step in the reduction of gold. He scoops out on the earth in an open place a hollow of the shape of a hemisphere about a foot in diameter, and having thoroughly smoothed the interior of this hollow, he

covers it with a layer of slaked lime about half an inch thick. After the lime has dried, it presents the appearance of a coarse white china vessel, imbedded in the earth. In this the balls prepared by the second process are placed. The *jamak-wala* then forms a powerful charcoal fire over it and with two or three large pairs of bellows causes the flame to play on the mass below. The lead of the *poonoor* is soon reduced and dissolves, as it were, the reduced gold, silver and copper. A large metallic mass thus collects at the bottom of the hollow, consisting mainly of lead. The blowing is now continued as hard as possible from above and the metal being oxidised to litharge begins to be blown off. The process must be continued till the whole of the lead has passed off and a mixture of gold, silver and copper remains behind. Care should always be taken in this operation to see that the last trace of lead is thoroughly got rid of; for nothing affects so much the ductility and malleability—virtues most important for the purposes of the goldsmith—of gold as a mixture ever so little of lead. Thus “one two-thousandth part renders the metal too brittle for rolling and its very fumes produce a serious effect upon it.”<sup>1</sup>

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(1) Maunder's Treasury of Science, Article : Gold.

Such is the tedious length and such the laborious and complicated nature of the processes by which the *neharwala* and the *jamakwala* extract precious metal from the large heaps of rejected sweepings and dirt and bye-products of the goldsmith's workshop. But their labours have only the empirical experience of years to guide them and not the acuteness of a well trained scientific mind ; and accordingly we find that a large portion of their work is directed to achieve in a laborious and round-about way an object which a slight knowledge of chemistry enables us to secure in the simplest manner imaginable.

With a view to shorten the labours of the *jamakwala* as far as possible, we began a series of experiments, investigating the properties of the *jamak* and trying to find out the easiest mode of extracting gold therefrom. As the results of our experiments we have found that, working on ordinary plans in the wet way, we can recover an amount of gold, which is equal to, if not in all cases greater than, the quantity which the *jamkawala* can obtain by his expensive and protracted methods.

We need scarcely give the properties and the constituents of the various specimens of *jamak*

which we obtained from the bazar from time to time for experimental purposes. The way in which a *jamak* is formed having been before described in full, the results of analyses will be nothing but tedious. It will be sufficient to observe that in all cases the *jamak* was a clear greenish-yellow liquid of rather thick consistency with a large mass of grey solid matter at the bottom consisting almost wholly of soluble saline matter.

It may be also added that among bases, silver, copper, zinc, gold, aluminium, potassium and sodium were the principal ones that were found; while amongst the acids present, nitric, sulphuric and hydrochloric were recognised in large quantities. Traces of free chlorine could also be found in some of the solution, while perceptible amounts of iron were found in almost all.

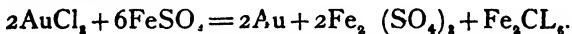
The microscopic appearance of *jamak* may be interesting as showing the exact state in which gold exists in the solution. With this view we examined under a microscope (magnifying 375 times) a drop of a clear solution of *jamak* as well as an amount of the solid saline matter lying at the bottom. The appearance, in both cases was the same, only in the latter the crystals were more numerous and closer together. The octahedra

of alum with occasional facets of cubes, the long furrowed and rhombic prisms of nitre and the cubes of common salt were very prominent. Between these, in numbers far less, could be discovered long, transparent needles. These were most probably crystals of double chloride of gold and sodium which is invariably formed when a solution of auric chloride is mixed with chloride of sodium. The constitution of this substance is  $\text{AuCl}_3 \cdot \text{NaCl} + 2\text{H}_2\text{O}$ , and it is the commercial "non-deliquescent chloride of gold" which is ordinarily sold in one gramme tubes.

Besides the above crystals, we frequently found amorphous particles, wholly or partially opaque. Those that did not transmit light at all were probably particles of dust or other earthy matter which were present in the ingredients in the shape of impurities. But there were others which transmitted a beautiful green light and these were likely to be fine particles of gold. As these were rather few in number, it might be inferred that in the *jamak*, gold existed chiefly in combination. It is also probable that the greatest part exists as  $\text{NaAuCl}_4 + 2\text{H}_2\text{O}$ .

From a liquid containing such a variety of substances in solution as the *jamak* does, it is no doubt a difficult task to precipitate the gold which is present perhaps in the minutest quantity of all.

The reducing agents that are mentioned by chemists as suited for reducing gold from solutions are exceedingly numerous. Of those that are practically employed, the principal ones are ferrous sulphate, oxalic acid, sulphurous acid metallic iron. We tried each of these in a large number of cases and found that ferrous sulphate gives the best result of all. The reaction that takes place during reduction by ferrous sulphate is something like the following :—



The gold is precipitated as a fine, heavy, black powder and easily settles at the bottom.

At first we used the pure material obtained from the chemists for precipitating *jamak*; but afterwards found that the crude article of the bazar, after being dissolved in water and filtered, yields a solution which serves equally well.

This makes the process a matter of very little expense and with an anna worth of good crystals of *hirakash* (the Bengali name of ferrous sulphate), a *jamak* containing 8 annas weight (for about Rs. 14 worth) of gold can be satisfactorily extracted.

We are far from thinking that in our experimental attempts to extract gold, we were able to catch the whole of the material that was present

in the solution. It is very probable that in the fine state of division, in which the precipitation takes place, a considerable amount of the metal is washed away in the process of collection. But this loss is due to causes of a mere physical nature and can be prevented to a large extent by the use of better and more refined instruments.

It has, however, been ascertained that even with rough instruments the easy and inexpensive mode of wet working gives as good results as the laborious and costly method of the *jamakwala*. The indigenous worker thinks himself fortunate if the amount of gold which he extracts is of twice the value of the *jamak* from which it is obtained, and we are convinced from the results of repeated experiments, that the wet method promises in general no less than twice the amount of profit with the advantage of saving time, labour and expense.

### CONCLUSION

The importance of the subject that has been described and discussed in the major portion of the preceding pages is far greater than it appears to be at the outset. Month after month, in Calcutta and in the larger towns of Bengal, considerable quantities of gold undergo transforma-

tion under the goldsmith's hammer; and as every article so manufactured is coloured before being used, the amount of *jamak* that is produced must be large indeed. By a rough calculation we have estimated that about 3500 persons earn their bread in calcutta by following the occupation of a manufacturing Jeweller; and allowing for holidays, illness and want of work it may be safely held that about 2,000 hammers ply on an average every day on gold and silver within the boundaries of Calcutta and its suburbs. Out of these 2,000 hands 1,500 may be supposed to work on the more precious metal of gold alone. On the modest calculation that a man works one-half of a tola of gold in the course of a day, 750 tolas of golden articles are turned out every day in the metropolis. Supposing as we have pointed out before that in colouring only one-half of an anna of weight of gold is dissolved out into the *jamak* per tola, as much as 375 annas or more than 23 tolas of gold are every day dissolved in Calcutta alone. As has been shown before, we have ample reasons to believe that the *jamakwala* can seldom get out as much as one-half the amount of gold that exists in the *jamak* by his crude and imperfect methods. Granting, however, that he can reclaim

so much as two-thirds of the gold lost in colouring, we are still forced to the astonishing conclusion that seven tolas of gold are absolutely lost in the town of Calcutta alone with the lapse of each day.

There can be little doubt that if the whole of the *jamak* that is now thrown away or otherwise washed could be collected and worked on the lines suggested by the newest and the most refined chemical methods, no less than three fourths of the entire loss could be reclaimed. This would amount to some thing like 15 or 16 lakhs of rupees per annum in these hard days of struggle for existence.

This is not the place for giving even the outlines of any elaborate scheme by which the collection of *jamak* and the extraction of gold therefrom may be carried out in practice on an extensive scale.

Business may be commenced at once by setting up a laboratory fitted up for the purpose after the latest fashion, at a convenient station in the centre of the Province and by purchasing the *jamak* that has already accumulated in the hands of the *rungwala*. In the meanwhile agencies may be established in every district for the purchase and storage of *jamak*. When the accumulated

*jamak* is all exhausted, these agencies will be able to feed the laboratory continually by the supply of fresh *jamak* from time to time, from all parts of the country.

#### NOTE ON THE SALTS. <sup>1</sup>

Romaka, also called *Sākambarī*, is the salt produced from the Sambar Lake near Ajmere (Dutt).<sup>1</sup>

Sauvarchala : see under saltpetre.

Audbhida (lit. begot of the soil) is the name applied to the saline deposit commonly known as the *reh* efflorescence. It consists "chiefly of sodium chloride and sulphate in varying proportions. In addition there are sometimes carbonate of soda, and we have usually found some magnesian sulphate. In certain localities the last named salt is in very considerable proportion. In other cases nitrate of lime or alkali is present."

"The efflorescences thus produced consist of three groups; 1st, the neutral, which contain no carbonate of soda (these consist chiefly of sodium chloride and sulphate, and frequently magnesium sulphate); 2nd, the alkaline chlorides and sulphates, but no lime or magnesian salt; 3rd, the nitrous efflorescences."—Dr. Center's Note on

*Reh* quoted in Watt's Dictionary of the "Economic Products of India". Vol. VI. Part I. pp. 410-417.

We have thus a ready explanation of the conversion of mercury and other metals into their chlorides when they were heated in combination with *audvida* and other salts (see p. 48). The magnesium sulphate would readily yield sulphuric acid, which with sodium chloride and nitre, might be expected to produce aqua regia ; (for further information see under "*rasakarpúra*" or the chlorides of mercury).

*Vida* or *Vit* is at present taken to be the same substance as the *kálánimak* or "black salt" ; it is difficult to ascertain what it stood for at the time of the *Charaka* and the *Susruta*. The following account is given in Watt's Dictionary of the Economic Products of India. "BLACK SALT is prepared in upper India chiefly at Bhewani in the Hissar district by heating together in a large earthen pot 82½ of common salt, one pound of the fruit of *Terminalia chebula*, and one pound of *Phyllanthus emblica*, and one pound of *sajji* (impure carbonate of soda), until by fusion of the salt the ingredients are well mixed, when the pot is removed from the fire and its contents allowed to cool and form a hard cellular mass. This prepa-

ration is used medicinally principally as a digestive." The salt has a reddish brown colour and consists mainly of sodium chloride with traces of sodium sulphate, alumina, magnesia, ferric oxide and sulphide of iron. Most of the samples, we have examined, were found to evolve minute quantities of sulphuretted hydrogen when treated with an acid; even when placed in the mouth the *taste* of this gas was distinctly felt. It is very probable that when the saline mass is fused with the organic matter [T. chebula], a portion of the sodium sulphate is reduced to sulphide, which by double decomposition converts the traces of iron salt present into the sulphide. The sulphide was detected both in the insoluble residue (as FeS) as well as in the aqueous extract.

In the Chemistry of Bubacar, the following salts are mentioned :—

*La classe des sels* renferme onze espèces : le sel commun, que l'on mange, le sel pur, le sel amer, employé par les orfèvres, le sel rouge<sup>1</sup>, le sel de naphte<sup>2</sup> le sel gemme proprement dit, le sel indien<sup>3</sup>, le sel alcalin,<sup>4</sup> le sel d'urine, le sel de

---

(1) Sel gemme coloré.

(2) Sel gemme bitumineux.

(3) Salpêtre ?

(4) Carbonate de soude.

cendres <sup>1</sup>, le sel de chaux <sup>2</sup>. (La Chimie au moyen âge, T. I. p. 308).

It will be seen, however, that the last 3 or 4 products are in Hindu Chemistry very properly placed under the kshāras or the alkalies (p. 45).

#### NOTE ON THE KILLING OF METALS

From the time of the Charaka and the Susruta we find metallic preparations in the shape of oxides, sulphides and sometimes chlorides recommended for internal administration. The various formulas, which will be found scattered throughout above, give us methods for *killing* the metals.<sup>3</sup> But a *killed* metal is not necessarily a compound; it sometimes means a metal deprived of its well characterised physical properties, *e.g.* colour, lustre &c. Thus the Ayurvedic *killed* gold and silver often represent the respective metals, in a fine state of division. Take for instance the following recipe from "Rasaratnākara" by Nityanātha :—  
 "Rub gold leaf with 4 times its weight of *killed*

(1) Carbonate de potasse.

(2) Potasse caustique impure.

(3) See pp 30-31, 48 72-73.

mercury (*i. e.* sulphide of mercury) and sublime the mixture in a closed crucible. On repeating the process 8 times, the gold is killed." (Cf. also the processes described in pp. 105-106). In the preparation of "makaradhvaja" (p. 132, note) the gold, which is left behind, would be regarded in the same light. As the Hindu Iatro-chemists were very particular about the *killing* of the metals being ensured, they had often to hit upon proper tests for securing this purpose. Thus "Rasaratnākara" says:—"In order to examine whether the mercury has been completely reduced to ashes, it has to be heated over a gentle fire for 3 hours. If the weight remains constant, know then that it has been completely killed." In other words it means that if there be any free mercury present, it would volatilise off and thus there would be a loss in weight. In page 118 will also be found some tests for *killed* iron. The language of a portion of couplets 25-28 is somewhat obscure and the meaning seems to be the very reverse of what the context would suggest ; "*killed iron is that which, on being mixed with treacle.....honey and heated, does not revert to the natural state.*" By "natural state" the author probably conveys *the state in which it originally was.*

*i.e* of an oxide, as immediately below he figuratively speaks of *the resurrection of the dead* (p. 120). Indeed, the ideas of the alchemists of the East and the West ran so closely on parallel lines that the best commentary we can offer to the above is the following extract from Hoefer's work, describing the notions current among the old Egyptians.

"*Expérience.* On brûle, on calcine du plomb ou tout autre métal (excepté l'or et l'argent) au contact de l'air. Le métal perd aussitôt ses propriétés caractéristiques, et se transforme en une substance pulvérulente, en une espèce de cendre ou de chaux. En reprenant ces cendres, qui sont, comme on disait, le résultat de la *mort du métal*, et en les chauffant dans un creuset avec des grains de froment, on voit bientôt le métal renaître de ses cendres, et reprendre sa forme et ses propriétés premières.

"*Conclusion* :—Le métal, que le feu détruit, est *revivifié*<sup>1</sup> par les grains de froment et par l'action de la chaleur. (T. I. p. 228).

"N'est-ce pas là opérer le miracle de la *résurrection*?"

T. I. p. 228

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(1) Les mots *revivifier*, *revivification* sont encore aujourd'hui employés comme synonymes, de *réduction de désoxydation*.

Other "experiences" as well as technical terms have also their exact analogues in the language of the Western alchemists. Thus side by side with the "tests for killed mercury" (p. 74) and the "process for the fixation of mercury" (p. 131) we may quote :

"Viennent ensuite toutes sortes de recettes pour la "combustion" de l'argent, de l'or, du cuivre de l'étain, etc., faisant parfois double emploi avec le livre II. Rappelons ici que le mot *combustion* signifiait la calcination des métaux en présence de diverses matières spécialement le soufre, le mercure, les sulfures métalliques, etc. Les produits en étaient dès lors fort multiples.—"La Chimie au moyen âge", 1. p. 309.

"La calcination du mercure était appelée à cette époque coagulation ou fixation du métal" *Ibid.* p. 154.

The passage in Rasārṇava describing the efficacy of the apparatus especially the line "without the use of herbs and drugs mercury can be killed with the aid of an apparatus alone" (p. 67.) is highly significant. It refers no doubt to the formation of the red oxide of mercury, the precipitate *per se*. Cf. "Il s'agit de la fabrication de l'oxyde de

mercure préparé *per se*, c'est-à-dire sans addition d'aucun corps étranger." *Ibid*, p. 154

ON THE HINDU METHOD OF MANUFACTURING  
CALOMEL; THE HINDU AND JAPANESE  
METHODS COMPARED—THE EXPLA-  
NATION OF THE REACTIONS INVOLVED

According to the Hindu alchemists, there are four kinds of the ash (*bhasma*) of mercury, namely black (*kajjali*, p. 61), red (vermilion), white and yellow.<sup>1</sup> The white variety is often spoken of as *rasakapūra* or camphor of mercury; it is often found to be almost pure calomel and sometimes a mixture in indefinite proportions of calomel and corrosive sublimate.

The chlorides of mercury are found to be medicinally used from the 12th century downwards and various recipes are given for their preparation. The earliest account seems to occur in *Rasārnava* (ch. XI. 24), where we find a mixture among other drugs of green vitriol, alum and salt, described as

(1) कज्जलि, रक्तभस्म. or रससिन्दूर; श्वेतभस्म and पीतभस्म  
Vide—रसैन्द्रसारसंग्रहः what the yellow ash refers to is not easy to make out.

capable of "killing mercury in an instant" (see p. 73). A more detailed description is found in "Rasendrachintāmaṇi" a work which may safely be placed in the 13th-14th century. Says the author Dhundhukanātha : "I am now going to explain the process of preparing rasakarpūra, which is a remedy for all diseases: take a strong earthen pot and fill one-fourth of it with common salt and place over it a mixture of brick-dust, alum and rock-salt. Rub mercury with the juice of Indian aloe and an equal weight of the above mixture into a paste; deposit it in the earthen pot and cover it with the same ingredients. The pot is to be firmly closed with a well-fitting lid. Now apply heat for three days together." <sup>1</sup>

(1) सर्वरोगहरो कर्पूरप्रक्रिया

स्याख्यां दृढघटितायामर्द्धं परिपूर्य तथ्यंलवणांशैः ।

रक्तेष्टकारजोभिस्तदुपरि सूतस्य तुर्यांशम् ॥

सितसैन्धवं निधाय स्फटिकारौ तत्समञ्च तस्योर्ध्वे ।

स्फटिकारिधवलसैन्धवशुद्धरसैः कन्याम्परिघृष्टैः ॥

कृत्वा पर्पटमुचितं तदुपर्याधाय तद्देव पुनः ।

स्फटिकारिसैन्धवरजो दद्यादितः स्रज्जतो रसस्य ॥

लाभय तदुपरि पर्परखण्डान् घृत्वा परया ।

दृढस्याख्यांकाद्य मुद्रयित्वा दिवसत्रितयं विपरीदधिना ॥

Another work of the Iatro-chemical period, "Rasendrasārasamgraha" describes the following process for obtaining the *svetabhasma* or white ash. "Rub mercury repeatedly with pāmsu salt (*i. e.* audbhida salt : see p. 243) and the juice of *Euphorbia neriifolia*; place the mixture inside an iron bottle, the mouth of which is closed with a piece of chalk. The bottle is embedded in a mass of salt (*cf.* the salt-bath, p. 123) and then fire is urged for an entire day. The white deposit in the neck of the bottle is to be collected." <sup>1</sup>

The Bhāvaprakāsa written about 1500 A. D. prescribes calomel in the treatment of *Phirangaroga* (*lit.* the disease of the Portuguese *i. e.* syphilis) and gives the following recipe: "Take of purified mercury, *gairika* (red-ochre), brick-dust, chalk, alum, rock-salt, earth from ant-hill, *kshāri lavana* (impure sulphate of soda) and *bhāndaranjika* or red earth used in colouring pots in equal parts, rub together and strain through cloth. Place the mix-

(1) पिटं पांशुपटु प्रगाढममलं वज्राशुना नैकशः

मृतं धातुगतं खट्टीकवर्धितं त मपटे रोषयेत् ।

अमलकजवचस्य तस्य च तले प्रज्वाल्य वर्धितं दृढं

चक्षुं शालामधेन्दुकन्दचक्षुं भस्मीपरिष्कृतं शनैः ॥

true in an earthen pot, cover it with another pot, face to face, lute the two together with layers of clay and cloth. The pots so luted are then placed on fire, and heated for four days, after which they are opened, and the white camphor-like deposit in the upper part is collected for use. " 1

- (1) शुद्धमृतसमं कृत्यात्प्रत्येकं गैरिकं सुधीः ।  
 इष्टिकां खटिकां तद्वत्स्फटिकां सिम्भुजम्बु च ॥  
 वल्लीकं चारुवर्णं भास्वरञ्जकमृत्तिकां ।  
 सर्वाण्येतानि ससूक्ष्मं वाससा चापि शोधयेत् ॥  
 अभिसूक्ष्मेयुतं मृतं यावदयानं विमर्दयेत् ।  
 तसूक्ष्मसंहतं मृतं स्थालीमध्ये परिचिपेत् ॥  
 तस्याः स्थाल्या सुखे स्थालीमपरां धारयेत्तन्नाम् ।  
 सवस्त्रकुटितमृदा मुद्रयेदनयोर्मुखम् ॥  
 संशीष्य मुद्रयेद्भूयोभूयः संशीष्य मुद्रयेत् ।  
 सम्यग्विशोष्य मुद्रां तां स्थालीं पुन्यां विधारयेत् ॥  
 अग्निं निरन्तरं दद्यादद्यावद्दिनचतुष्टयम् ।  
 अङ्गारोपरि तदयत्नं रक्षेद्दशदिनमग्नौ ॥  
 शनैरुद्घाटयेदयत्नमूर्ध्वालोगतं रसम् ।  
 कर्पूरवत्सुविमलं गृहीयाद्भुवनेतरम् ॥

The Japanese method has been described by Professor Divers at length<sup>1</sup> and a summary of it is given below in the eminent chemist's own words :—

“The Japanese prepare calomel pure. above all things from corrosive sublimate. They heat balls of porous earth and salt soaked in bittern along with mercury, in iron pots lined with earth. The heat forms hydrochloric acid from the magnesium chloride in the bittern, and the mercury sublimes into the close-fitting but unattached clay covers of the pots. Air enters by diffusion and oxygen and hydrochloric acid gas act together in the hollow cover on the vapour given off from the sublimate of mercury there formed.”

It will be seen that the process somewhat approaches that of “*Rasendrasārasamgraha*” in which the *pāmsu* salt, which contains magnesium sulphate (see p. 252) sets free hydrochloric acid. The recipe of “*Rasendrachintāmaṇi*” and *Bhāvaprakāśa* would seem to have their analogue in the Chinese method, for a short account of which we are also indebted to Professor Divers' Memoir :—

The translation from “*Bhāvaprakāśa*” as given above is by Dutt.

(1) “*Journ. Sec., Chem. Ind.*” Vol XIII. (1894) pp. 108-11.

“The Chinese process, *if correctly described*, differs from that used in Japan in several material points, one of which is that the mercury is intimately ground up with the other materials, and one fails to see what reaction can take place between it and the two others, namely salt and alum. Heated, the mixture must give off mercury and hydrochloric acid, and then these, as in the Japanese process, will with air give the calomel, but this is independent of the previous intimate mixture of the mercury with the salt and the alum. Another point is that in place of the magnesium chloride of sea-water as the source of hydrochloric acid, the Chinese are said to use alum or copperas, which, with the salt, will react to give hydrochloric acid. A third point is that the cover is said to be closely luted to the iron pot, which must nearly exclude the air, without which it is impossible to explain the formation of calomel. Perhaps this is the reason why the Chinese process is said to take four or five hours' firing, since this may give time enough for the needed oxygen to diffuse through the cup and luting, it will also account for the fact, if it is one, that the yield of calomel is markedly less in weight than the mercury used.”

The Chinese and Hindu methods<sup>1</sup> are essentially the same as in both alum plays an important part in that it yields sulphuric acid. Professor Divers in his explanation of the Japanese method supports the view that the hydrochloric acid at first liberated undergoes *aerial* oxidation, thus:  $2\text{HCl} + \text{O} = \text{H}_2\text{O} + \text{Cl}_2$ ; and it is the chlorine thus set free, which attacks the mercury, forming calomel—a view which has been accepted by no less an authority than Mendeléeff.<sup>2</sup> The author has all along entertained doubts as to the correctness of Divers' hypothesis and he has, in his lectures, pointed out to his students that some "catalytic agent" as in Deacon's process must account for the reaction involved. This now turns out to be so. It is the *ferric*

(1) To which may be added that of the Latin Geber:—

"Argentum vivum sic sublima. Sume de eq libram unam, vitrioli rubificati libras duas, aluminis rochae calcinati libram unam, et salis communis libram semis, et salis petrae quartam partem, et incorporatum sublima, et collige album, densum, clarum et ponderosum, quod circa vasis sponditia inventum fuerit, et serva, ut tibi de aliis scripsimus. Sed si in prima sublimatione inventum fuerit, turbidum vel immundum, quod tibi accidere poterit propter tuam neglegentiam, illud cum eisdem fecibus noveris iterum sublimare, et serva."—"Ges. d. Chem." IV. p. 189.

2) "Principles of Chemistry," Vol. II. p. 54 (Eng. trans. ed. 1897).

*oxide*, a constituent of the burnt earth "*mitsuchi*"<sup>1</sup> which really acts as the chlorinating agent, if we may so call it, in that it combines with the hydrochloric acid forming ferric chloride, and the latter in turn dissociates into *ferrous chloride* and *free chlorine*.

The alumina of the clay also plays a similar part. A series of experiments were undertaken to establish this point, the results of which are stated below:—

I. Mercury, intimately rubbed with moist magnesium chloride, was gently heated in a combustion tube in a current of carbonic acid gas: globules of mercury and hydrochloric acid condensed in the cooler parts of the tube, but no calomel was formed.

II. Mercury, intimately mixed with magnesium chloride and a small quantity of jeweller's *rouge*

---

(1) The composition of the earth, as found in use at the works, but rendered anhydrous, is as follows:—

|                 |     |     |      |
|-----------------|-----|-----|------|
| Quartz ...      | ... | ... | 38·4 |
| Combined Silica | ... | ... | 24·2 |
| Alumina ...     | ... | ... | 26·3 |
| Ferric oxide    | ... | ... | 10·5 |
| Magnesia        | ... | ... | 0·3  |

---

99·7

(ferric oxide), was treated exactly as above—a crystalline sublimate of calomel was at once obtained, with only a faint trace of corrosive sublimate. There was very little free mercury left.

III. The experiment under ii was repeated, only alumina being substituted for ferric oxide—almost chemically pure calomel was obtained, the yield being rather less.

IV. Mercury, was vapourised in a current of air mixed with hydrochloric acid gas—calomel was formed, but the yield was proportionately very much less than in i; by far the largest amount of mercury volatilised as such and condensed in the cooler parts of the tube as globules.<sup>1</sup>

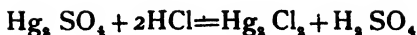
The formation of calomel as in exp. IV. is, in itself, an interesting reaction and it is rather surprising that Roscoe and Schorlemmer's latest edition of the standard work on Chemistry fails to take

---

(1) The author avails himself of this opportunity to express his indebtedness to Mr. Chandrabhúshana Bháduri, B.A., Demonstrator, Chemical Dept., Presidency College, with whom he has, of late, had frequent discussions on the chemistry of the Japanese Process. It was Mr. Bháduri who hit on the true explanation as given above. The experiments i, ii, iii and iv were all performed by him. As Mr. Bháduri has expressed a desire to work out the subject in all its bearings, we can confidently look forward to some very interesting results.

note of it. Our contention, however, is that the traces of air that would diffuse through the porous lid would give rise to a quantity of calomel which may almost be regarded as negligible. For the true explanation, as we have already pointed out, we should look to the presence of *ferric oxide*. Our view receives additional support from the fact that the residue in exp. ii. was found to contain *ferrous* chloride.

The Chinese method as also that of the Latin Geber recommends the addition of saltpetre as thereby more of corrosive sublimate would be formed than calomel, and this purpose is equally served in the process of Bhāvaprakāśa which uses, over and above brick-dust, *gairika* (red ferruginous earth, see p. 139, thus further increasing the chlorinating capacity. Professor Divers is of opinion that the sulphuric acid set free by alum acts upon sodium chloride giving rise to hydrochloric acid (loc. cit.) and does nothing more; our view is that the sulphuric acid simultaneously acts in a two-fold capacity; first, it liberates hydrochloric acid; secondly, it acts upon mercury forming mercurous or mercuric sulphate as the case may be and then double decomposition takes place between the two, thus :



The sulphuric acid in turn acts upon a fresh quantity of sodium chloride and mercury and so on. By far the larger portion of the chlorides of mercury would seem, however, to be formed through the agency of the ferric oxide.

The processes of "Rasendrachintāmaṇi" and "Bhāvaprakāsa" were also put to an experimental test, the globules of mercury were broken up by being rubbed continuously with a mixture of brick-dust, alum and common salt, and the mass was transferred to a stout bottle, which was wrapped in several folds of cloth, smeared with clay<sup>1</sup>. The bottle was embedded in sand and heated for 3 hours<sup>2</sup>—*vide* illustration. The sublimate that was obtained was a mixture of calomel and mercuric chloride; in one experiment brick-dust

(1) The experiments were conducted under the author's personal supervision by Kavirāj Prakṛitiprasanna Kaviratna, who is well skilled in the Hindu methods of *killing* metals.

(2) The heating for 3 or 4 days together as recommended in the Hindu method need not be taken seriously, indeed it must be regarded as an *extravagance* of the old alchemists. Professor Divers in applying his theory of *aerial oxidation* to the Chinese process has been led to suppose that it "takes 4 or 5 hours' firing, since this may give time enough for the needed oxygen to diffuse through the cup and luting."

was omitted and the product was pure calomel<sup>1</sup>. There was necessarily some loss of mercury by volatilisation in these cases and the yield was short of the theoretical quantity. It will be seen that common salt, with alum or green vitriol, is quite competent to convert mercury into calomel; but the addition of brick-dust increases the chlorinating capacity, giving rise to a certain proportion of corrosive sublimate, which can probably be avoided by gentle heating as in the Japanese method.

## APPENDIX I

### Analysis of some Preparations used in the Hindu Medicine

#### ÆTHIOPS MINERAL

(Kajjali or rasaparpati p. 61)

As might be expected from its mode of preparation, the substance always contains a large excess of free sulphur.

---

(1) Dutt writes :—"The white form called *rasakarpūra* is now prepared, not according to the processes described in Sanskrit works, but by subliming the black sulphide of mercury with common or rock salt. In this form it is largely manufactured and sold in all the bazars."

0.645 gram subst.; digested with carbon bisulphide, yielded 0.2845g. sulphur: whence free sulphur amounts to nearly 44 per cent.

### SULPHIDE OF COPPER

(Parpati tāmram p. 58)

0.704 g. subst., heated in a current of hydrogen with powdered sulphur (Rose's method); till the weight was constant, gave 0.697 g. It is thus evident that this preparation is nearly pure cuprous sulphide ( $\text{Cu}_2\text{S}$ ).

### CALOMEL

(Rasakarpūra, p. 250)

Five samples, procured from the market and prepared according to the indigenous method, when exhausted with water gave in the filtrate only faint brown coloration with sulphuretted hydrogen. It is thus evident that these were all free from corrosive sublimate.

---

Dutt, we are afraid, derived much of his information on chemical subjects from hearsay. By "subliming the black sulphide of mercury with common salt," we got, as we expected, merely *cinnabar*. The sodium chloride was simply left behind. It is to be regretted that the new edition of Dutt's valuable work, which claims to be "revised," reproduces all the glaring errors of the first.

## RUST OF IRON

(Mandūra, p. 111)

Hindu physicians generally procure the scales from the black-smith's forge, which peel off the red-hot bars of iron, when they are struck on the anvil with an iron hammer. These are subjected to further roasting, sometimes as many as 500 times and powdered very fine.

## Sample I

The powder was reddish brown in colour; and slightly magnetic; 0.6638 g was boiled a few hours with hydrochloric acid in a current of carbonic acid gas. On adding a drop of potassium ferricyanide solution to a drop of the iron solution, a faint blue colour was noticed. Weight of insoluble residue, which was simply siliceous matter, was equal to 0.107 g; the oxide of iron was therefore equal to  $0.6638\text{g} - 0.107\text{g} = 0.5568\text{g}$ . The solution, distinctly yellow in colour, was treated with ammonia and the precipitate, ignited in the usual way, weighed 0.560 g. The sample was thus practically ferric oxide ( $\text{Fe}_2\text{O}_3$ ).

## Sample II.



In the Hindu method of *killing* and purifying metals, the juices expressed from various plants are frequently used (cf. pp. 61, 132). The ashes of plants rich in potash are also utilised as a source of alkali. (Cf. pp. 35-36). We give below one or two typical analyses.

(i) *Achyranthes aspera* (अचामान) ।

"The ashes are used by the Hindus in preparing alkaline preparations. The diuretic properties of the plant are well known to the natives of India, and European physicians agree as to its value in dropsical affections.

\* \* \* \*

*Chemical composition.*—The whole plant collected in August was used. A proximate analysis failed to indicate the presence of any principle of special interest. No alkaloidal body was detected, and the alcoholic extract contained no principle reacting with ferric salts.

"For the ash determination, the roots, stems and leaves were separately examined with the following results :—

|                      | LEAVES.                | STEMS.         | ROOTS.         |
|----------------------|------------------------|----------------|----------------|
| $P_2O_5$ .....       | 3'0257                 | 2'6939         | 1'8504         |
| $SiO_2$ as Sand..... | 39'7192                | 12'9716        | 21'4219        |
| $SO_2$ .....         | 1'3200                 | 2'6534         | 3'9523         |
| $CaO$ .....          | 13'8893                | 13'1233        | 12'9335        |
| $MgO$ .....          | 3'4778                 | 3'5149         | 5'4419         |
| $K_2O$ .....         | 17'8454                | 32'0008        | 28'5830        |
| $Na_2O$ .....        | .....                  | .....          | 0'9860         |
| $Fe_2O_3$ .....      | 2'7931                 | 3'0352         | 5'6297         |
| Manganese.....       | Traces, not estimated. | Not estimated. | Not estimated. |
| KCl.....             | 5'7416                 | 9'5221         | .....          |
| NaCl.....            | 1'1770                 | 1'5261         | 3'2951         |
| $Al_2O_3$ .....      | 2'0651                 | Not estimated. | Not estimated. |
| $CO_2$ .....         | 8'8687                 | 13'6294        | 11'0057        |
| Carbon.....          | 3'297                  | 5'525          | Not estimated  |
|                      | 100'2526               | 95'2232        | 95'1085        |

"The leaves, stems, and roots dried at  $100^{\circ}C.$ , afforded respectively the following percentages of ash,—Leaves, 24'334; stems, 8'672; roots, 8'863. The large amount of sand present in the ash is due to the fact of the plants having been collected during the rains, and when received they were coated with finely divided siliceous matter.

"The total potash calculated as  $K_2O$  was equivalent in the leaves to 21'4986 per cent., in the

stems to 38.0122 per cent., and in the roots to 28.5830 per cent. It is possible that the plant might be of value as a cheap green manure on account of potash content. (Warden, *Chem. News*, Vol. ii., 1891)."

(ii) Juice of *Trianthema monogyna* (चैतपुनर्नवा) †

Although *Punarnava* is *Boerhaavia diffusa*, the plant universally used by our *Kavirajes* as चैतपुनर्नवा, is different. A sample was submitted to the authorities of the Royal Botanical Gardens, Sibpur, for examination, and it was indentified as *Trianthema monogyna* (nat. ord. Ficoidæ). On chemical analysis of the juice of the succulent stems, we found it to consist of a large proportion of potassium and sodium chlorides; a nitrate was also detected. The cooling and diuretic properties of the plant are thus easily explained.



# **APPENDIX II**

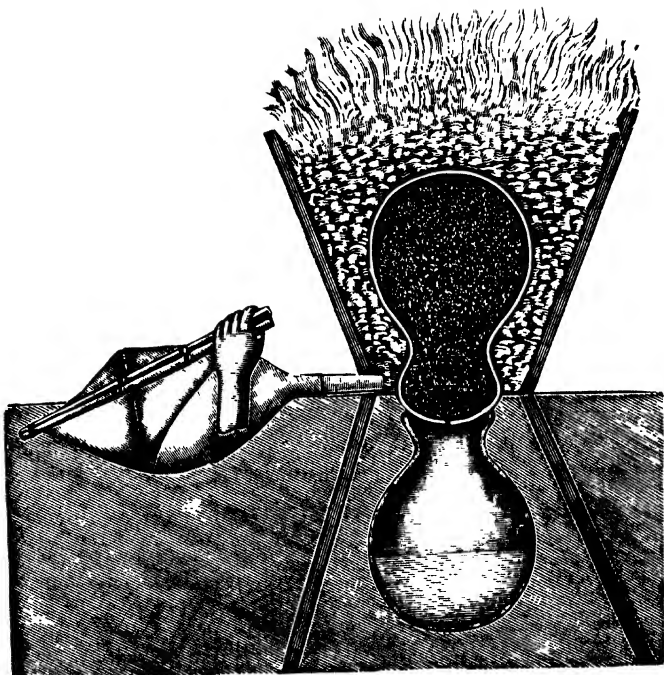


Sir P. C. Ray  
at young age



Sir P. C. Ray at old age





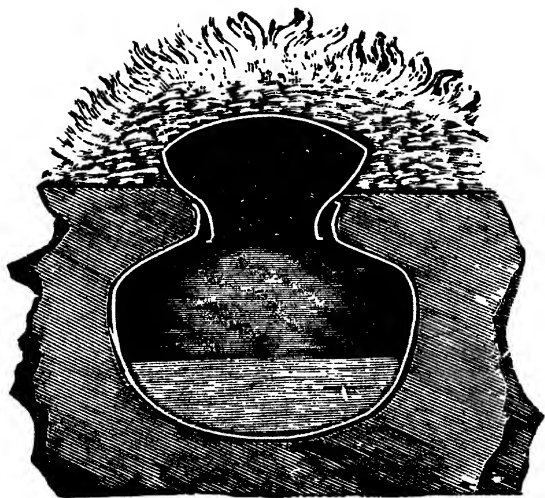
Koshthi apparatus,  
for the extraction of zinc from calamine. (See p 89)



Dolā vantram. (See p. 121)



Svedanī yantram. (See p. 122)

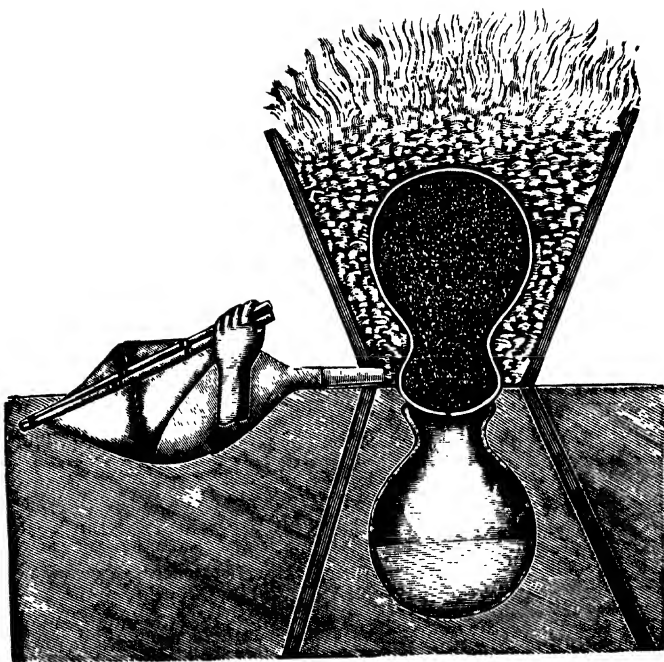


*Adhaspātana yantram.* (See p. 122).



Valuka vantram (See p 123)

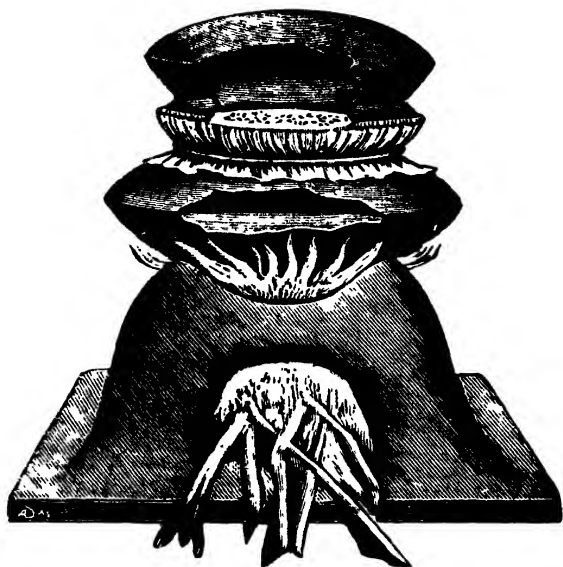




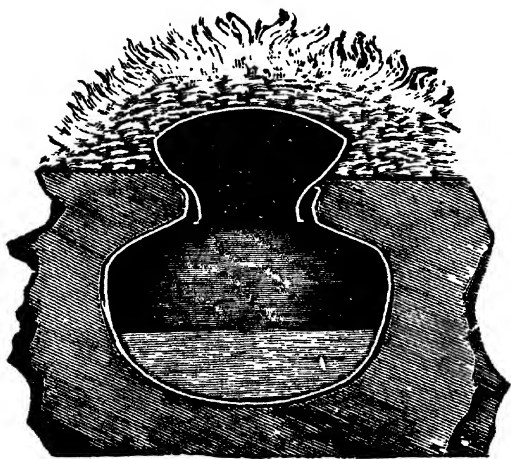
Koshthí apparatus,  
for the extraction of zinc from calamine (See p. 89)



Dolā yantram. (See p. 121)



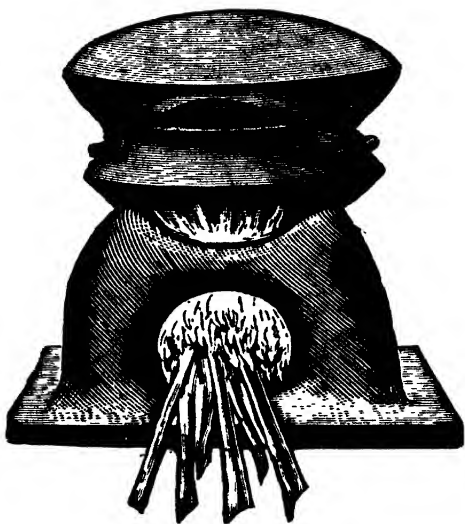
Svedanī yantram. (See p. 122)



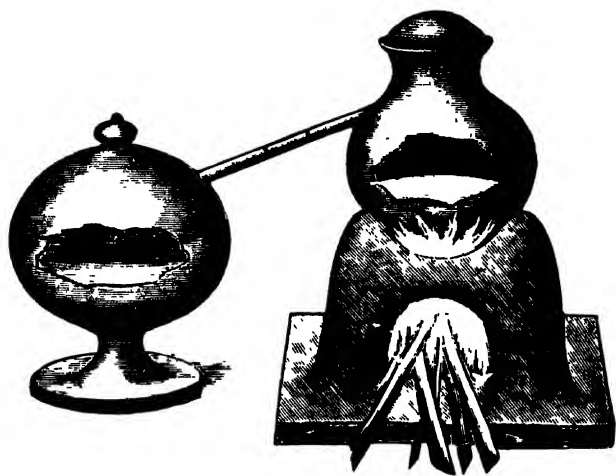
Adhaspātana yantram. (See p. 122).



Valuka yantra (See p. 123)



**Pātatnā yantram.** (See p. 122).



*Dhokì yantram.* (See p. 123)

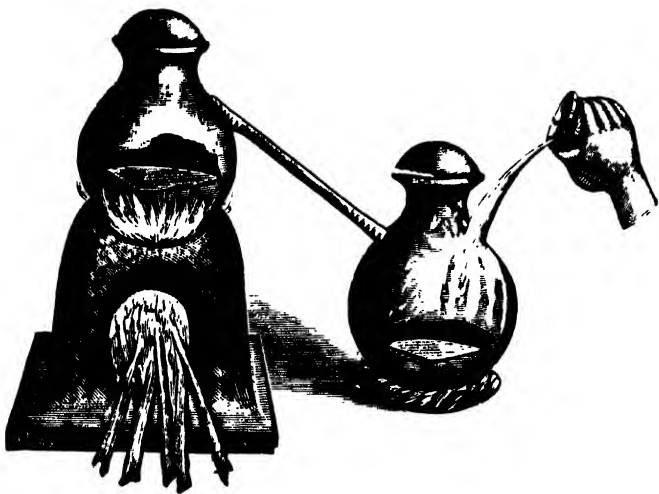


Alum and Sulphate of Copper Works Khetri.

From Ball's Economic Geology of India (See p 148)



Tiryakpātana yantram. (See. p. 124).



Vidyādhara yantram. (See p. 124).



Dhūpa yantram. (See p. 125)



Copper Reducing Furnace at Khetri.

From Ball's Economic Geology of India. (See p 140-41)

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# **SANSKRIT TEXTS**



# Sanskrit Texts

## Extracts from Vrinda

Abbreviations used : M. Ms. = Madras Manuscript.

K. Ms. = Káśmír Manuscript.

R. R. S. = Rasaratnasamuchchaya.

Rr. by Nág. = Rasaratnākara by  
Nágárjuna.

वृन्दलिखितसिद्धयोगादुद्धृतानि वचनानि—

रसेन्द्रेण समायुक्तो रसो धत्तूरपत्रजः ।

ताम्बूलपत्रजो वाय लेपनं यौकनाशनम् ॥ VI, 13.

निफलाव्योषसिन्धूत्ययष्टीतुत्यरसाञ्जनम् ।

प्रपौण्डरीकं जम्बुघ्नं लोध्रं ताम्रं चतुर्दश ॥

द्रव्याखेतानि संचूर्ण्य वर्तिः कार्त्तया नभोऽम्बुना ।

नागार्जुनेन लिखिता स्तम्भे पाटलिपुत्रके ॥

LX, 148-149.

सर्वेषां लोहजातानां कान्तं भवति काम्तिदम् ।

\* \* पाचयेन्नोहमादौ सप्तदिने ततः ॥

धात्रीपिण्डारकोद्भूतस्वरसेनार्करस्मिषु ।

स्थापयेत् \* \* \* ॥

काकमाचीरसे पश्चात् \* \* ।

पुनश्चैकान्ते सर्वत्र खलितव्यं प्रयत्नतः ॥

पश्चाच्चूर्णं विधातव्यमप्रमत्तेन धीमता ।

इति सूर्यमुखेनैव मारणं परिकौर्त्तितम् ॥

\* \* \* \* लोहमारणम् ।

रसगन्धकताम्राणां चूर्णं कृत्वा समाक्षिकम् ।

पुटपाकविधौ पक्त्वा मधुनालोष्य संलिहेत् ॥

सर्वरोगहरश्चैतत्पर्पटाख्यं रसायनम् ॥

पर्पटीताम्रं, रसायनाधिकारः ।

कर्षद्वयं गन्धकस्य तदर्धं पारदस्य च ।

विडालपदमावन्तु लिङ्घान्तमधुसर्पिषा ॥<sup>1</sup>

रसामृतचूर्णम्, अम्लपित्ताधिकारः ।

(1) The ed. of १८८८ published by the Anand&-arama Press, Poona, does not contain the last three slokas, which, however, occur in the K. Ms. of the same.

## Extracts from Rasarnava

### रसार्णवाद्भुताः श्लोकाः ।

श्रीभैरव उवाच—

रसोपरसलोहानि वसनं काञ्चिकं विडम् ।  
धमनी लोहयन्त्राणि खल्लपाषाणमर्दकम् ॥  
कीटिका वक्रनालञ्च गोमयं सारमिन्धनम् ।<sup>1</sup>  
मृन्मयानि च यन्त्राणि मुसलोलूखलानि च ॥  
संङ्सीयन्त्रसंदंशं मृत्पात्रायःकरोटकम् ।<sup>2</sup>  
प्रतिमानानि च तुला छेदनानि कषोत्पलम्<sup>3</sup> ॥  
वंशनाली लोहनाली मूषामार्गास्तथौषधी ।  
स्नेहान्नलवणक्षारविषाण्युपविषाणि च ॥

(1) Cf. कीटिका वक्रनालञ्च गोमयं सारमिन्धनम् ।

Rr. by Nāg. Ch. IV.

(2) M. Ms. reads मण्डपोपङ्गसन्दंशं मृत्पात्रं श्लेष्मोरकम् ।

(3) M. Ms. has कषोत्पलम् ।

एवं संगृह्य सञ्चारं कर्मयोगं समाचरेत् ॥  
 द्रवद्रव्येण भाण्डस्य पूरितार्द्धोदरस्य च<sup>1</sup> ।  
 मुखे तिर्यक्कृते भाण्डे रसं सूत्रेण लम्बितम् ।  
 तं स्वेदयेत्तत्र गतं दीलायन्मिति स्मृतम् ॥  
 लोहमूषाद्वयङ्गत्वा द्वादशाङ्गुलमानतः ।  
 ईषच्छिद्रां छिद्रमिता<sup>2</sup>मेकां गन्धकसंयुतान् ॥  
 मूषायां रसयुक्तायामन्यस्यां तां प्रवेशयेत् ।  
 तोयं स्यात्सूतकस्याध ऊर्ध्वो वज्रिदीपनम् ॥  
 रसोनकरसं भद्रे यत्नतो वस्त्रगालितम् ।  
 दापयेत्पचुरं यत्नादाग्राव्य रसगन्धकौ ॥  
 स्थालिकायां निधायोर्ध्वं स्थालीमन्यां दृढां कुरु ।  
 सन्धिं विलेपयेद्यत्नाद्भृदा वस्त्रेण चैव हि<sup>3</sup> ॥

(1) K. Ms. reads भाण्डच पूरितार्द्धोदरेण च । The reading adopted in the text is that of the M. Ms., which quite agrees with R. R. S. (see p. 73, Poona ed.)

(2) M. Ms. reads ईषच्छिद्रां निधायमेकाम् ।

(3) Rr. by Nág. reads मध्ये तु रससंस्कारितः ।

स्थात्यन्तरे कपोताख्यं पुटं कर्षाग्निना सदा ।  
 यन्त्रस्याधः करीषाग्निं दद्यात्तीव्राग्निमेव च ॥  
 एवन्तु त्रिदिनं कुर्यात्तप्ततोये विमर्दयेत् ॥  
 न तत्र क्षीयते सूतो न च गच्छति कुत्रचित् ॥  
 ऊर्ध्वं वह्निरधश्चापो मध्ये तु रससङ्ग्रहः ।  
 मूषायन्त्रमिदं देवि जारयेद्<sup>1</sup>गन्धकादिकम्<sup>2</sup> ॥  
 गर्भयन्त्रं प्रवक्ष्यामि पिष्टिकाभस्मकारकम् ।  
 चतुरङ्गलदीर्घां<sup>3</sup> च मूषिकां मृन्मयीं दृढाम् ॥

(1) M. Ms. has सारधन

(2) गगनादिकम् in R. S. S. (p. 74, Poona ed.)  
 Complets लोहमूषादयं . . . . गच्छति कुत्रचित have been  
 borrowed by R. R. S: in the Book on apparatus.

(3) Rr. by Nág. reads—

चतुरङ्गलदेर्ध्वे विस्तारं च त्र्यङ्गलम् ।  
 मूषान्तु मृन्मयीं कुर्यात् सदृशं वर्तुलां बुधः ॥  
 विंशभागानि लोहस्य भागमेकान्तं गुग्गुलाः ।  
 सुस्रज्जं पिषयित्वा तु तीर्थं दत्त्वा पुनः पुनः ॥  
 मूषालपं दृढं ब्रह्म लोहार्थं मृत्तिकां बुधः ।  
 कुर्यात्तुषाणि भूमौ च मदुस्त्रिदिनं स्वेदयेत् ॥

अङ्गुलमध्यविस्तारं वर्तुलं कारयेन्मुखम् ।  
 लोहस्य<sup>1</sup> विंशतिर्भागा एकभागस्तु गुग्गुलीः ॥  
 सुश्लक्ष्णं पेषयित्वा त त्तोयं दद्यात्पुनः पुनः ।  
 मूषालेपं ततः कुर्यात्तिलपिष्टञ्च निक्षिपेत्<sup>2</sup> ॥  
 कुर्यात्तुषाग्निं भूमौ च<sup>3</sup> मृदुस्नेदन्तु कारयेत् ।  
 अहोरात्रं त्रिरात्रं वा रसेन्द्रो भस्मतां व्रजेत् ॥  
 जारणे सारणे चैव रसराजस्य रञ्जने ।  
 यन्त्रमेव परं कर्म यन्त्रविद्या महाबला ॥<sup>4</sup>  
 औषधिरहितस्यायं हठाद्यन्त्रेण वध्यते ।  
 तस्माद्यन्त्रबलञ्चैकं न विलंघ्यं विजानता ॥ 3-24.  
 खर्परं सिकताकारं कृत्वा तस्योपरि न्यसेत् ॥  
 अपरं खर्परं तत्र शनैर्भृङ्गिना पचेत् ॥  
 पञ्चक्षारैस्तथा मूत्रैर्लवणैश्च विद्धैस्ततः ।  
 हंसपाकः स विज्ञातो<sup>5</sup> यन्त्रतत्त्वार्थकोविदैः ॥

(1) K. Ms. reads लोणस्य ।

(2) K. Ms. has तिलपिष्टं सुनिक्षिपेत् ।

(3) M. Ms. reads तुषकषाग्निना भूमौ ।

(4) M. Ms. has यन्त्रौषधं परं कर्म यन्त्रौषध्या महाबलम् ।

(5) M. Ms. reads हंसपादस्तु विज्ञातः ।

कृष्णा रक्ता च पीता च शुक्लवर्णा<sup>1</sup> च मृत्तिका ॥  
 आद्या श्रेष्ठा कनिष्ठा च मध्यमा मध्यमा मता ॥  
 दग्धधान्यतुषोपेता मृत्तिका कोष्ठकारिका<sup>2</sup> ।  
 वक्रनालकृते वापि शस्यते सुरसुन्दरि ॥  
 गौरा दग्धा तुषा दग्धा दग्धा वल्मीकमृत्तिका ।  
 अजाश्वानां मलं दग्धं दग्धा मृत्कृष्णतां गता ॥  
 वासकस्य च पत्राणि वल्मीकस्य मृदा सह ।  
 पेषयेदग्नितोयेन अनेन वज्रतां गतम् ॥  
 मर्हयेत्तेन बध्नीयाद्वक्रनालञ्च कोष्ठकम् ॥  
 गौरा दग्धा तुषा दग्धा दग्धा वल्मीकमृत्तिका ॥  
 चिरमङ्गारकः किट्टं वज्रेणापि न भिद्यते ।  
 दग्धाङ्गारस्य षड्भागा भागैका कृष्णमृत्तिका ॥  
 चिरमङ्गारकः किट्टं वज्रमूषा प्रकीर्त्तिता ॥  
 तुषदग्धसमा दग्धमृत्तिका चतुरंशिका ।  
 घर्म्मपाषाणसंयुक्ता<sup>3</sup> वज्रमूषा प्रकीर्त्तिता ॥

(1) M. Ms. has शुक्लकृष्णा ।

(2) M. Ms. reads कोष्ठकावधौ ।

(3) M. Ms. has कुष्मापाषाणसंयुक्ता :

प्रकाशा चान्वमूषा च प्रकृतिर्द्विविधा स्मृता ।  
 प्रकाशमूषा देवेशि शरावाकारसंयुता ॥  
 द्रव्यनिर्वाहणे सा च वैदिकैः सुप्रशस्यते ॥<sup>1</sup>  
 अन्वमूषा तु कर्त्तव्या गोस्तनाकारसन्निभा ;  
 पिधानकसमायुक्ता किञ्चिदुत्तानमस्तका ॥  
 पत्रलेपे तथा भागे<sup>2</sup> इन्द्रमेलापके तथा ।  
 सैवाच्छिद्रान्विता मध्ये गम्भीरा सारणोचिता ॥  
 मोक्षचारस्य<sup>3</sup> भागौ द्वौ दृष्टकांशसमन्वितौ ।  
 मृद्भागास्तारशुद्धार्थमुत्तमा वरवर्णिनि ॥ 29-46.  
 आवर्त्तमाने कनके पीता तारे सिता शुभा ॥  
 शुक्ले<sup>4</sup> नीलनिभा तीक्ष्णे कृष्णवर्णा सुरेश्वरि ॥  
 वज्रे ज्वाला कपोता च नागे मलिनधूमता ॥  
 शैले तु धूसरा देवि आयसे कपिलप्रभा ॥

(1) M. Ms. reads सा चावैदिकैः सुप्रशस्यते ।

(2) M. Ms. has रङ्गे ।

(3) M. Ms. reads मोक्षचारस्य ।

(4) K. Ms. has शुक्ले, which seems to be incorrect.

अयस्कान्ते धूमवर्णा सस्यके लोहिता भवेत् ॥  
वज्रे नानाविधा ज्वाला सस्यके<sup>1</sup> पाण्डुरप्रभा ॥

न विस्फुलिङ्गा न च बुद्बुदाश्च

यदा न रेखापटलं न शब्दः ।

मूषागतं रत्नसमं स्थिरञ्च

तदा विशुद्धं प्रवदन्ति लोहम् ॥

षोडशाङ्गुलविस्तीर्णं हस्तमात्रायतं शुभम् ।

धातुसत्त्वनिपातार्थं कोष्ठकं वरवर्णिनि ॥ 49-57.

इति श्रीपार्व्वतीपरमेश्वरसंवादे रसार्णवे रस-  
संहितायां यन्त्रमूषाग्निवर्णनो नाम चतुर्थः पटलः ।

त्रिचाराष्टङ्गणक्षारो यवक्षारश्च सर्जिका ।

तिलापामार्गकदलीपलाशशियुमोचकाः ।

मूलार्द्रकचिच्चाश्वत्था वृक्षक्षाराः प्रकीर्त्तिताः ॥

V. 35-36.

माद्विकं विमलं शैलं<sup>2</sup> चपलो रसकस्तथा ।

(1) M. Ms. reads खसखे

(2) K. Ms. has शिला ।

सस्यको दरदस्यैव स्रोतोऽञ्जनमयाष्टकम्<sup>1</sup> ।

षष्टौ महारसाः \* \* \* ॥ VII. 2-3.

क्षौद्रगन्धर्व्वतैलाभ्यां गोमूत्रेण घृतेन च ।

कदलीकन्दसारेण भावितं माक्षिकं मुहुः ।

मूषायां मुञ्चति क्षातं सत्त्वं शुक्लनिभं मृदु ॥ 12-13.

विमलं शिशुतोयेन काञ्चीकासीसटङ्गणैः ।

वज्रकन्दसमायुक्तं भावितं कदलीरसैः ॥

मोक्षिकाचारसंयुक्तं धापितं मूकमूषया ।

सत्त्वं चन्द्रार्कसङ्काशं प्रयच्छति न संशयः ॥<sup>2</sup> 20-21.

गौरः खेतोऽरुणः कृष्णश्चपलस्तु प्रशस्यते ।

हेमाभस्यैव ताराभो विशेषाद्रसबन्धकः ॥

(1) K. Ms. reads स्रोताञ्जनमयाष्टकम्, which is incorrect.

(2) विमलं शिशुतोयेन काञ्चीकासीसटङ्गणैः ।

वज्रकन्दसमायुक्तं भावितं कदलीरसैः ॥

मोक्षिकाचारसंयुक्तं धापितं मूकमूषगम् ।

सत्त्वं चन्द्रार्कसङ्काशं पतति नात्र संशयः ॥

Rr. by Nāg. II. 35, 36.

शेषौ मध्यौ च लाक्षावच्छीघ्रद्रावौ तु निष्कलौ ।  
 वङ्गवद्भवते वङ्गौ चपलस्तेन कीर्तितः ॥ 26-27.  
 मृत्तिकागुडपाषाणभेदेतो<sup>1</sup> रसकस्त्रिधा ॥ VII. 31.  
 किमत्र चित्रं रसको रसेन,  
 \* \* \* भावितः ।  
 क्रमेण भूत्वा तुरगेण रञ्जितः  
 करोति शुक्लं<sup>2</sup> त्रिपुटेन काञ्चनम् ॥<sup>3</sup> VII. 34.  
 जर्णालाक्षातथापथ्या-भूलताधूमसंयुतः ।  
 मूकमूषागतो धातष्टक्केन समन्वितः ॥  
 सत्त्वं कुटिलसङ्काशं मुञ्चत्यत्र न संशयः ॥<sup>4</sup>  
 VII. 37-38.

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- (1) M. Ms. has भेदकः ।  
 (2) M. Ms. reads गन्धम् ।  
 (3) This sloka is exactly the same as it is in  
 Rr. by Nāg. I. 3.

(4) जर्णालाक्षातथापथ्या-भूलताधूमसंयुतः ।

क. पागती धातष्टक्केन समन्वितः ।

सत्त्वं कुटिलसङ्काशं पतति नात्र संशयः ।

Rr. by Nāg. II. 31-32.

सस्यकं \* \* \* \*

शशशोणितमध्ये वा दिनमेकं निधापयेत् ।

तस्य चूर्णं महेशानि पादसौभाग्यसंगु तम्<sup>1</sup> ॥

करञ्जतैलमध्यस्थं दिनमेकं निधापयेत् ।

मध्यस्थमन्धमूषायां धापयेत्कोकिलान्नयम् ॥

इन्द्रगोपकसङ्काशं सत्त्वं पतति शोभनम् ॥ VII. 41-44.

गोपित्तेन शतं वारान् सौराष्ट्रीं भाषयेत्ततः ॥

धमित्रा पातयेत्सत्त्वं क्रामणश्चातिगुह्यकम् ॥

VII. 72-73.

\* \* \* \* शृणु लोहान्यतः परम् ।

सुवर्णं रजतं ताम्रं तीक्ष्णवङ्गभुजङ्गमाः ।

लोहकं षड्विधं तच्च यथापूर्वं तदक्षयम् ॥ VII. 89-90.

रसजं<sup>2</sup> क्षैत्रजश्चैव. लोहसङ्करजं तथा ।

त्रिविधं जायते हेम चतुर्थं नोपलभ्यते ॥ VII. 92.

लोहानां मारणं वक्ष्ये समाहितमनाः शृणु ।

\* \* \* \* \*

(1) M. Ms. reads पादसाम्राज्यसंगुतम् ।

(2) M. Ms. has रजस्तं, which is doubtful.

नास्ति तल्लोहमातङ्गो यन्न गन्धककेशरी ।

निहन्याद्गन्धमात्रेण यदा मात्तिककेशरी ॥

VII. 138-142

इति श्रीपार्वतीपरमेश्वरसवाटे रसार्णवे रस-  
संहितायां महारसोपरसरत्नलोहलक्षणसंस्कारनिर्णयो  
नाम सप्तमः पटलः ।

श्रीभैरव उवाच--

कासीसं सैन्धवं मात्ती सौवीरं व्योषगन्धकम् ।

सौवर्चलं व्योषका च मालतीरससम्भवः ॥<sup>1</sup>

शिशुमूलरसैः सिक्तो विडोऽयं सर्वजारणः ।<sup>2</sup>

IX. 2-3.

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(1) Ms. Ms. has सर्जिका and मालतीरससम्भवम् ।

(2) Cf. Rasakalpa II. 51-66. Here व्योषगन्धकौ,  
सर्जिका and रससंयुतैः seem to be correct.

गन्धतालकसिन्धूत्यचूलिकाशृङ्गं तथा ।  
 चारैर्मूचैश्च विपचेदयं ज्वालामुखो विडः<sup>1</sup> ॥

\* \* \* \* \*

एवं संगृह्य सन्भारं रसकर्म समाचरेत् ।  
 तन्ममाचक्ष्व देवेशि किमन्यच्छ्रोतुमिच्छसि ॥

IX. 9-20.

इति श्रीपार्वतीपरमेश्वरसंवादे रससंहितायां  
 विडकथनो नाम नवमः पटलः ।

काकमाची जया ब्राह्मी मार्जारी रक्तचित्रकः ।  
 मण्डूका मुद्गपर्णी च शृङ्गवेरं सशाङ्करम् ॥  
 देवदाली शङ्खपुष्पी काकजङ्घा शतावरी ।  
 कुमारी भृङ्गराजश्च निर्गुण्डी ग्रीष्मसुन्दरः ।  
 शूलिनी सूर्यपर्णी च गोजिह्वा क्षीरकशुकः ॥

X. 52-54.

(1) K. Ms. reads चयं ज्वालामुखो विडः, which is grammatically incorrect.

तद्रसैः सर्व्वदा<sup>1</sup> पात्यः सप्तधा निर्मलो भवेत् ।  
यामेन<sup>2</sup> पिष्टिकां कृत्वा पातयेद्दूर्ध्वापातने ।  
वङ्गनागौ परित्यज्य शुद्धो भवति सूतकः ॥

X. 55-56.

कासीसतुवरीसिन्धुटङ्गणक्षारसंयुतः ।  
पूर्व्वभेषजयोगेन सूतकश्चरति क्षणात् ॥ XI. 24.  
सौवर्चलश्च कासीसं सामुद्रं सैन्धवं तथा ।  
आसुरी टङ्गणश्चैव नवसारस्तथैव च ॥  
कर्पूरश्चैव माक्षीकं समभागानि कारयेत् ॥  
सुहृत्कर्कदुग्धैर्देवेशि मूषालेपन्तु कारयेत् ॥  
विडचूर्णं ततो दत्त्वा कनकं जारयेन्प्रिये ॥

XI. 83-86.

नानावर्णं भवेत्सूतं विहाय घनचापलम् ।  
लक्षणं दृश्यते यस्य मूर्च्छितं तं वदन्ति हि ॥  
भार्द्रत्वं चपलत्वं<sup>3</sup> च तेजो गौरवचापलम् ।

(1) M. Ms. has नर्दितम् ।

(2) M. Ms. reads तामेन ।

(3) M. Ms. reads घनत्वम्, which is preferable.

यस्यैतानि न दृश्यन्ते विद्यात्तं मृतसूतकम् ॥<sup>1</sup>

XII. 197-198.

तीक्ष्णं नागं तथा शुल्वं रसकेन तु रञ्जयेत् ।

समस्तं जायते हेम कुष्माण्डकुसुमप्रभम् ॥ XII. 50.

पञ्चभूतात्मकः सूतस्तिष्ठत्येव सदाशिवः ॥ XII. 78.

भस्मसूतं पलैकञ्च पलमेकञ्च<sup>2</sup> गन्धकम् ।

पुटेन जायते भस्म सिन्दूरारुणसन्निभम् ॥ XIV. 81.

मयूरग्रीवतुल्यञ्च कुङ्कुमं रसकं तथा ।

बालवत्सपुरीषञ्च विषं हालाहलं तथा ॥

रक्तचित्रकचूर्णन्तु समभागानि कारयेत् ।

मर्दयेन्मध्यमान्नेन छायाशुष्कञ्च कारयेत् ॥

(1) Cf. चाद्रैत्वञ्च घनत्वञ्च चापल्यं गुरुतेजसः ।

यस्यैतानि न दृश्यन्ते तं विद्यान्मृतसूतकम् ॥

नागावर्णे भवेत्सूतं विहाय घनचापलम् ।

लघुञ्च दृश्यते यस्य मूर्च्छितं तं वदन्ति हि ॥

Rr. by Nág. IV.

(2) M. Ms. has \* \* \* पलैकं पन्नगञ्च च ।

ताम्रपात्रेण तं कृत्वा मर्दयेन्नीहसृष्टिना ।

सहस्रिणा ततः पाण्यं यावन्नागिन मीचनम् ॥

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मधुना सह संयोज्य नागपत्राणि लेपयेत् ।

मूकमूषागतं धातं नागं रक्षयति क्षणात् ॥

अशोकपत्ररसेन सप्तवारं निषेचयेत् ।

षष्टाविंशतिकृत्वो वै तैले भूनागसम्भवे ॥

तन्नागं जायते दिव्यं देवाभरणभूषणम् ॥

XVII. 70-74.

Extracts from  
**Rasaratnasamuchchaya.**

B. = Benares Manuscript.

K. = Kāśmīr Manuscript.

**अथ प्रथमोऽध्यायः ।**

**रसोत्पत्तिः ।**

यस्यानन्दभवेन मङ्गलकलासम्भावितेन स्फुर-  
द्यान्ना सिद्धरसामृतेन करुणावीक्षासुधासिन्धुना ।  
भक्तानां प्रभवप्रसंहतिजरारागादिरोगाः क्षणा-  
च्छान्तिं यान्ति जगत्प्रधानभिषजे तस्मै परस्मै नमः ॥ 1.

आगम<sup>1</sup>सुन्दरसेनश्च लङ्केशश्च विशारदः ।

कपाली मत्तमाण्डव्यौ भास्करः शूरसेनकः ॥

(1) आगमः, a variant in the Poona ed., which also agrees with B. and K.

रत्नकोषश्च<sup>1</sup> शम्भुश्च सात्त्विको नरवाहनः ।  
 इन्द्रो गोमुखश्चैव कम्बलिव्याडिरेव च ॥  
 नागार्जुनः सुरानन्दो नागबोधिर्यशोधनः ।  
 खण्डः कापालिको ब्रह्मा गोविन्दो लम्पको हरिः ॥  
 सप्तविंशतिसंख्याका रससिद्धिप्रदायकाः ।  
 रसाङ्गुशो भैरवश्च नन्दी स्वच्छन्दभैरवः ॥  
 मन्यानभैरवश्चैव काकचण्डीश्वरस्तथा ।  
 वासुदेव ऋष्यशृङ्गः<sup>2</sup> क्रियातन्त्रसमुच्चयी ॥  
 रसेन्द्रतिलको योगी भालुकी मैथिलाद्वयः ।  
 महादेवो नरेन्द्रश्च वासुदेवो हरीश्वरः<sup>3</sup> ॥ 2-7.  
 एतेषां क्रियतेऽन्येषां तन्त्राख्यालोक्य सङ्ग्रहः ।  
 रसानामथ सिद्धानां चिकित्सार्थोपयोगिनाम् ॥

(1) रत्नकोषश्च, another reading in the Poona ed., which also agrees with B. and K.

(2) ऋष्यशृङ्गः, a different reading in the Poona ed., which also agrees with B. and K.

(3) K. reads रत्नाकरहरीश्वरी, which is probably the correct reading.

सूनुना सिंहगुप्तस्य रसरत्नसमुच्चयः ।  
 रसोपरसलोहानि यन्त्रादिकरणानि च ॥  
 शुद्धयर्थमपि लोहानां तन्त्रादिकरणानि च ।  
 शुद्धिः सत्त्वं द्रुतिर्भस्मकरणञ्च प्रवक्ष्यते ॥ 8-10.  
 हन्ति भक्षणमात्रेण पूर्वजन्माघसम्भवम् ।  
 रोगसङ्क्रमशेषाणां नराणां नात्र संशयः ॥ 26.  
 यश्च निन्दति सूतेन्द्रं शम्भोस्तेजः परात्परम् ।  
 स पतेन्नरके घोरे यावत्कल्पविकल्पनाम् ॥ 29.  
 पतितो दरदे देशे गौरवाद्द्विवक्त्रतः ।  
 स रसो भूतले लीनस्तत्तद्देशनिवासिनः ।  
 तां मृदं पातनायन्त्रे क्षिप्त्वा सूतं हरन्ति च ॥

89-90.

इति श्रीवैद्यपतिसिंहगुप्तस्य सूनोर्वाग्भटाचार्यस्य  
 छतौ रसरत्नसमुच्चये रसोत्पत्तिर्नाम प्रथमोऽध्यायः ।

## अथ द्वितीयोऽध्यायः ।

महारसाः ।

- अभ्रवैक्रान्तमाक्षीकविमलाद्रिजसम्यकम् ।  
 चपलो रसकश्चेति ज्ञात्वाष्टौ सङ्गहेद्रसान् ॥ 1.  
 पिनाकं नागमण्डूकं वज्रमित्यभ्रकं मतम् ।  
 खेतादिवर्णभेदेन प्रत्येकं तच्चतुर्विधम् ॥ 5.  
 खेतं रक्तञ्च पीतञ्च कृष्णमेवं चतुर्विधम् ॥ 10.  
 सुखनिर्मोच्यपत्रञ्च तदभ्रं शस्तमीरितम् ॥ 12.  
 सचन्द्रिकञ्च किट्टाभं व्योम न यासयेद्रसम् ।  
 ग्रसितञ्च नियोज्योऽसौ लोहे चैव रसायने ॥ 13.  
 निचन्द्रिकं मृतं व्योम सेव्यं सर्वगदेषु च ।  
 सेवितं चन्द्रसंयुक्तं मेहं मन्दानलं चरेत् ॥ 14.  
 प्रतप्तं सप्तवाराणि निक्षिप्तं कान्तिकेऽभ्रकम् ।  
 निर्दोषं जायते नूनं प्रक्षिप्तं वापि गोजले ।  
 त्रिफलाकथिते चापि गवां दुग्धे विशेषतः ॥ 17-18.  
 चूर्णाभ्रं शालिसंयुक्तं वस्त्रबहं हि कान्तिके ।  
 निर्यातं मर्हनाइस्त्राद्याभ्रमिति कथ्यते ॥ 23.

धान्यान्नं कासमर्हस्य रसेन परिमर्दितम् ।

पुटितं दशवारेण म्रियते नात्र संशयः ॥ 24.

अथ वैक्रान्तः—

षष्टास्रष्टाष्टफलकः षट्कोणो मष्टणो गुरुः ।

शुद्धमिश्रितवर्णैश्च युक्तो वैक्रान्त उच्यते ॥

श्वेतो रक्तश्च पीतश्च नीलः पारावतच्छविः ।

श्यामलः कृष्णवर्णश्च कर्बुरष्टाष्टधा हि सः ॥ 55-56.

आयुःप्रदश्च बलवर्णकरोऽतिवृष्यः

प्रज्ञाप्रदः सकलदोषगदापहारी ।

दीप्ताग्निशक्तं पविसमानगुणस्तरस्वी

वैक्रान्तकः खलु वपुर्बललोहकारी ॥

रसायनेषु सर्वेषु पूर्वगण्यः प्रतापवान् ।

वज्रस्थाने नियोक्तव्यो वैक्रान्तः सर्वदोषहा ॥

57-58.

\* \* वैक्रान्तं वज्राकारं महारसम् ।

बिम्बस्य दक्षिणे वाऽस्ति ह्युत्तरे वाऽस्ति सर्व्वतः ।

विक्रामयति लोहानि तेन वैक्रान्तकः स्मृतः ॥

60-61.

वैक्रान्तकाः स्युस्त्रिदिनं विशुद्धाः

संस्त्रेदिताः चारपटूनि दत्त्वा ।

षष्ठेषु मूत्रेषु कुलत्परम्भा-

नीरेऽथवा कोद्रववारिपक्काः ॥

कुलत्परकाथसंस्त्रिन्नो वैक्रान्तः परिशुध्यति ।

म्रियतेऽष्टपुटैर्गन्धनिम्बुकद्रवसंयुतः ॥ 67-68.

भस्मीभूतस्तु वैक्रान्तं वज्रस्थाने नियोजयेत् ॥

मोक्षमोरटपालाशचारगोमूत्रभावितम् ।

वज्रकन्दनिशाकल्कफलचूर्णसमन्वितम् ।

तत्कल्कं टङ्कणं लाक्षाचूर्णं वैक्रान्तसम्भवम् ॥ 70-71.

नवसारससायुक्तं मेषशृङ्गीद्रवान्वितम् ।

पिण्डितं मूकमूषस्थं क्षापितञ्च हठाग्निना ॥ 72.

तत्रैव पतते सत्त्वं वैक्रान्तस्य न संशयः ॥ 73.

अथ माक्षिकम्—

सुवर्णशैलप्रभवो विष्णुना काञ्चनो रसः ।

तापीकिरातचीनेषु यवनेषु च निर्मितः ॥ 77.

(1) तापी, a variant in the Poona ed., which also agrees with B. and K.

माक्षिकं द्विविधं हेममाक्षिकन्तारमाक्षिकम् ।

तत्राद्यं माक्षिकं कान्यकुञ्जोत्थं स्वर्णसन्निभम् ॥ 80.

पाषाणबहलः प्रोक्तस्तारास्थोऽल्पगुणात्मकः ॥ 81.

मातुलुङ्गाम्बुगन्धाभ्यां पिष्टं मूषोदरे स्थितम् ।

पञ्चक्रोड़पुटैर्दग्धं म्रियते माक्षिकं खलु ॥ 84.

क्षौद्रगन्धर्वतैलाभ्यां गोमूत्रेण घृतेन च ।

कदलीकन्दसारेण भावितं माक्षिकं सुदुः ।

मूषायां सुश्रुति धातं सत्त्वं शुल्बनिभं मृदु ॥<sup>1</sup>

89-90.

अथ विमलः—

विमलस्त्रिविधः प्रोक्तो हेमाद्यस्तारपूर्वकः ।

तृतीयः कांस्यविमलस्तत्तत्कान्था स लक्ष्यते ॥ 96.

वर्तुलः कोणसंयुक्तः स्निग्धश्च फलकान्वितः ॥ 97.

गन्धाश्मलकुचास्त्रैश्च म्रियते दशभिः पुटैः ॥ 100.

सटङ्कलकुचद्रावैर्मेघशृङ्गाश्च भस्मना ।

पिष्टा मूषोदरे लिप्तः संशोष्य च निरुध्य च ॥

(1) Verses 89-90 as also 103-104 occur both in Rasārṇava and Rr. by Nág. ; the Poona ed. reads पतते नाच संशयः in the place of प्रयच्छति न संशयः ।

षट्प्रत्यकोकिलैर्धातो विमलः सीससन्निभः<sup>1</sup> ।  
सत्त्वं मुञ्चति तद्युक्तो रसः स्यात्स रसायनः ॥

101-102.

विमलं शिग्रतोयेन काक्षीकासीसटङ्कणैः ।  
वज्रकन्दसमायुक्तं भावितं कदलीरसैः ॥  
मोक्षकक्षारसंयुक्तं धापितं मूकमूषगम् ।  
सत्त्वं चन्द्रार्कसङ्काशं प्रयच्छति न संशयः ॥

103-104.

अथ शिलाधातुः—

शिलाधातुर्हिधा प्रोक्तो गोमूत्राद्यो रसायनः ।  
कर्पूरपूर्वकस्तान्यस्तत्राद्यो द्विविधः पुनः ॥ 109.  
ग्रीष्मे तीव्रार्कतप्तेभ्यः पादेभ्यो हिमभूभृतः ।  
स्वर्णरूप्यार्कगर्भेभ्यः शिलाधातुर्विनिःसरत् ॥

110-111.

अथ सस्यकम्—

मयूरकण्ठवच्छायं भाराक्यमतिशस्यते ॥ 127.

(1) Both the B. and K. Mss. read सीससन्निभः ।

The Pnoo3 ed. gives a variant श्रीतसन्निभः ।

मयूरतुल्यम्—

रसायनं वमनरेककरं गरुडं

श्लिषापहं गदितमत्र मयूरतुल्यम् ॥ 129.

लकुचद्रावगन्धाश्मटङ्गणेन समन्वितम् ।

निरुध्य मूषिकामध्ये म्रियते कौकुटैः पुटैः ॥ 132.

सस्यकस्य तु चूर्णन्तु पादसौभाग्यसंयुतम् ।

करञ्जतैलमध्यस्थं दिनमेकं निधापयेत् ॥

मध्यस्थमन्धमूषाया<sup>1</sup> धापयेत्कोकिलत्रयम् ।

इन्द्रगोपाकृतिं चैव सत्त्वं भवति<sup>2</sup> शोभनम् ॥ 133-134.

निम्बुद्रवाल्पटङ्गाभ्यां मूषामध्ये निरुध्य च ।

ताम्ररूपं परिधातं सत्त्वं मुञ्चति सस्यकम् ॥ 135.

शुद्धं सस्यं शिखिकान्तं<sup>3</sup> पूर्वमेषजसंयुतम् ।

नानाविधानयोगिनः सत्त्वं मुञ्चति निश्चितम् ॥ 136.

(1) The Poona ed. reads चन्धमूषास्यमध्यस्थम् । We have adopted the reading of Rasārṇava.

(2) पतति, another reading in the Poona ed., which also agrees with B. K. and Rasārṇava.

(3) The Poona ed. reads शिखाकान्तम् ।

अथ चपलः—

गौरः खेतोऽरुणः कृष्णश्चपलस्तु चतुर्विधः ।  
 हेमाभश्चैव ताराभो विशेषाद्रसबन्धनः ॥ 143.  
 शेषी तु मध्वी लाक्षावच्छीघ्रद्रावी तु निष्कली ।  
 वङ्गवद्भवते वङ्गो चपलस्तेन कीर्तितः ॥<sup>1</sup> 144.  
 चपलः स्फटिकच्छायः षड्रसः<sup>2</sup> सिन्धुको गुरुः ॥  
 146.

अथ रसकः—

रसको द्विविधः प्रोक्तो दुर्दुरः कारवेक्षकः ।  
 सदलो दुर्दुरः प्रोक्तो निर्दलः कारवेक्षकः ॥ 149.  
 खर्परः परिसन्तप्तः सप्तवारं निमज्जितः ।  
 बीजपूररसस्यान्तर्निर्मलत्वं समश्रुते ॥  
 नृमूत्रे वाश्चमूत्रे वां तक्ने वा काष्ठीकेऽथवा ।  
 प्रताप्य मज्जितं सम्यक् खर्परं परिशुध्यति ॥ 154-155.

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Slokas 143 and 144 are from Rasārnava.

(2) षड्रसः, another reading in the Poona ed. which we have adopted. Slokas 143-146 are evidently borrowed with slight modifications from Rasārnava, VII. 26-27.

हरिद्रात्रिफलारालसिन्धुभूमैः सटङ्कणैः ।  
 सारुष्करैश्च पादांशैः सान्धैः सम्मर्द्य खर्परम् ॥  
 लिप्तं हन्ताकमूषायां शोषयित्वा निरुध्य च ।  
 मूषां मूषोपरि<sup>1</sup> न्यस्य खर्परं प्रधमेत्ततः ॥  
 खर्परं प्रहृते ज्वाला भवेन्नीला सिता यदि ।  
 तदा सन्दंशतो मूषां धृत्वा कृत्वा त्वधोमुखीम् ।  
 शनैरास्फालयेद्भूमौ यथा नालं न भज्यते ॥  
 वङ्गाभं पतितं सत्त्वं समादाय नियोजयेत् ॥

157-161.

लाक्षागुडासुरीपथ्याहरिद्रासर्ज्जटङ्कणैः ।  
 सम्यक्क्षुण्णं तत्पक्वं गोदुग्धेन घृतेन च ।  
 हन्ताकमूषिकामध्ये निरुध्य गुटिकाकृति ।  
 धात्वा धात्वा समाकृष्य ढालयित्वा शिलातले ।  
 सत्त्वं वङ्गाकृतिं ग्राह्यं रसकस्य मनोहरम् ॥

163-164.

(1) मूषां मूषोपरि, a variant in the Poona ed., which also agrees with B. and K.

यद्वा जलयुतां स्थालीं निखनेत्कोष्ठिकोदरे ।  
 सच्छिद्रं तन्मुखे मल्लं तन्मुखेऽधोमुखं<sup>1</sup> क्षिपेत् ।  
 मूषोपरि शिखित्रांश्च प्रक्षिप्य प्रधमेद्बुद्धम् ।  
 पतितं स्थालिकानीरे सत्त्वमादाय योजयेत् ॥

165-166.

तत्सत्त्वं तालकोपेतं प्रक्षिप्य खलु खर्परे ।  
 मर्दयेन्नोद्दण्डेन भस्मीभवति निश्चितम् ॥ 167-168.

## अथ तृतीयोऽध्यायः ।

अथोपरसाः साधारणरसाश्च ।

अथ गन्धकः—

गन्धाश्चगैरिकासीसकाक्षीतालशिलास्त्रनम्  
 कङ्कुष्ठश्चेत्युपरसाश्चाष्टौ पारदकर्म्मणि ॥ 1.

(1) तन्मुखेऽधोमुखं. a variant in the Poona ed.,  
 which we have adopted.

स चापि त्रिविधो देवि शुक्लचक्षुर्निभो वरः ।  
 मध्यमः पीतवर्णः स्याच्छुक्लवर्णोऽधमः प्रिये ॥ 12.  
 चतुर्धा गन्धको ज्ञेयो वर्णैः श्वेतादिभिः खलु ।

\* \* \* \* \*

दुर्लभः कृष्णवर्णश्च स जरामृत्युनाशनः ॥ 13-15.  
 गन्धको द्रावितो भृङ्गरसे क्षिप्तो विशुध्यति ॥ 23.  
 स्थाव्यां दुग्धं विनिक्षिप्य मुखे वस्त्रं निरुध्य च ।  
 गन्धकं तत्र निक्षिप्य चूर्णितं सिकताकृति ।  
 ह्लादयेत्पृथुदीर्घेण खर्परैर्गैव' गन्धकम् ॥  
 ज्वालयेत्खर्पगस्थोर्द्धं वनच्छाणैस्तथोपलैः ।  
 दुग्धे निपतितो गन्धो गलितः परिशुध्यति ॥ 24-25.

अथ गैरिकम्—

पाषाणगैरिकञ्चैकं द्वितीयं स्वर्णगैरिकम् ।  
 पाषाणगैरिकं प्रोक्तं कठिनं ताम्रवर्णकम् ॥ 46.  
 गैरिकम् तु मवां दुग्धैर्भावितं शुद्धिमृच्छति ॥ 49.

अथ कासीसम्—

कासीसं बालुकाद्यैकं पुष्पपूर्वमथापरम् । 51.  
 तुवरीसत्त्ववत्स्वमेतस्यापि समाहरेत् ॥ 54.

अथ तुवरी—

सौराष्ट्रशमनि सम्भूता<sup>1</sup> श्रुत्वा सा तुवरी मता ।

वस्त्रेषु लिप्यते यासौ मञ्जिष्ठारागबन्धिनी ॥

\* \* फुल्लिका चेति द्वितीया परिकीर्त्तिता ।

प्रेष्यतीता गुरुस्निग्धा \* \* \*

निर्भाराः सुन्वयणी च स्निग्धा मास्त्रापरा मता ।

सा फुल्लतुवरी प्रोक्ता स्निपात् ताम्रं चरिदयः ॥<sup>59-62</sup>

काक्षी कषाया कटुक्रास्त्रकण्ठ्या

कण्ठ्या व्रणघ्नी विषनाशनी च ।

खिलापद्धा पत्रहिता त्रिदोष-

शान्तिनदा पारदजारणी च ॥<sup>63</sup>

तुवरी काञ्चिच्च क्षिप्त्वा त्रिदिनाच्छुद्धिमृच्छति ।

क्षारास्त्रैर्मर्दिता धाता सत्त्वं मुञ्चति निश्चितम् ॥<sup>64</sup>

गोपित्तेन शतं वारान् सौराष्ट्रीं भावयेत् ततः ।

धमित्वा पातयेत् सत्त्वं कामणं चातिगुह्यकम् ॥<sup>65</sup>

(1) सौराष्ट्रशमनि, a variant in the Poona ed., which also agrees with B. and K.

अथ तालकम्—

हरितालं द्विधा प्रोक्तं पत्राख्यं <sup>1</sup>पिण्डसंज्ञकम् ।

स्वर्णवर्णं गुरु स्निग्धं तनुपत्रं च भासुरम् ॥ 66.

स्निग्धं कुष्माण्डतोये वा तिलक्षारजलेऽपि वा ।

तोये वा चूर्णसंयुक्ते दोषायन्त्रेण शुध्यति ॥ 69.

मधुतुल्ये घनीभूते कषाये ब्रह्ममूलजे ।

त्रिवारं तालकं भाष्यं पिष्ट्वा मूत्रेऽथ माहिषे ॥

उपलैर्दशभिर्देयं पुटं रुद्धाय पेषयेत् ।

एवं द्वादशधा पाच्यं शुद्धं योगेषु योजयेत् ॥ 74-75.

पलालकं रवेर्दुग्धैर्दिनमेकं विमर्दयेत् ।

क्षिप्त्वा षोडशिकातैले मिश्रयित्वा ततः पचेत् ॥

अनावृतप्रदेशे च सप्तयामावधि ध्रुवम् ।

स्वाङ्गशीतमधःस्थं च सत्त्वं श्वेतं समाहरेत् ॥ 80-81.

अथ मनःशिला—

अष्टमांशेन किट्टेन गुडगुग्गुलुसर्पिषा ।

कोष्ठ्यां रुद्धा दृढं ध्यात्वा सत्त्वं मुञ्चेन्मनःशिला ॥ 95.

(1) The Poona ed. reads पत्राख्यं and K. reads पत्राख्यं, which we have adopted.

अथाञ्जनानि—

सौवीरमञ्जनं प्रोक्तं रसाञ्जनमतः परम् ।

स्रोतोऽञ्जनं तदन्यच्च पुण्याञ्जनकमेव च ॥

नीलाञ्जनं च तेषां हि स्वरूपमिह वर्ण्यते ।

सौवीरमञ्जनं धूम्रं रक्तपित्तहरं हिमम् ॥ 98-99.

अञ्जनानि विशुध्यन्ति भृङ्गराजनिजद्रवैः ।

मनोज्ञासत्त्ववत् सत्त्वमञ्जनानां समाहरेत् ॥

वल्मीकशिखराकारं भङ्गे नीलोत्पलद्युति ।

घृष्टं तु गौरिकण्डायं स्रोतोऽञ्जनं लक्षयेद्बुधः ॥

गोशलादुरसमूत्रेषु घृतक्षौद्रवसासु च ।

भावितं बहुशस्तच्च शीघ्रं बध्नाति सूतकम् ॥ 1 (5-167

अथ कङ्कुष्ठम्—

हिमवत्यादशिखरे कङ्कुष्ठमुपजायते । 109.

केचिददन्ति कङ्कुष्ठं सद्योजातस्य दन्तिनः । 111.

वदन्ति श्लेष्मपीताभं तदतीवविरेचनम् । 112.

अथ साधारणरसाः—

कम्बिजश्च परो गौरीपाषाणो नवसारकः ।

कपर्दी बङ्गिजारश्च गिरिसिन्दूरहिङ्गुली ॥

मृदारशृङ्गमित्यष्टौ साधारणरसाः स्मृताः ।

रससिद्धिकराः प्रोक्ता नागार्जुनपुरःसरैः ॥ 120 121.

अथ कम्प्लेक्सः—

इष्टिकाचूर्णसङ्काशस्रन्दिकाव्योऽतिरेचनः ।

सौराष्ट्रदेशे चोत्पन्नः स हि कम्प्लेक्सकः स्मृतः ॥ 122

अथ गौरीपाषाणः—

स्फटिकाभश्च शङ्खाभो हरिद्राभस्त्रयः स्मृताः ।

तालवद्वाहयेत् सत्त्वं शुद्धं शुभ्रं प्रयोजयेत् ॥ 124-126

अथ नवसारः—

करीरपीलुकाष्ठेषु पच्यमानेषु चोद्भवः ।

क्षारोऽसौ नवसारः स्याच्चूलिकालवणाभिधः ॥

इष्टिकादहने जातं पाण्डुरं लवणं लघु ।

तदुक्तं नवसाराख्यं चूलिकालवणं च तत् ।

रसेन्द्रजारणं लोहद्रावणं जठराग्निकृतम् ॥

गुल्मघ्नीहास्यशोषघ्नं भुक्तमांसादिजारणम् ॥ 127 129.

अथ वराटकाः—

पीताभा ग्रन्थिका वृष्टे दीर्घवृत्ता वराटिका ।

रसवैद्यैर्विनिर्दिष्टा सा चराचरसंज्ञिका ॥ 130.

वराटाः काञ्चिके स्विन्ना यामाच्छुद्धिमवाप्नुयुः ॥ 134

अथाग्निजारः—

समुद्रेणाग्निनक्रस्य जरायुर्वहिरुज्झितः ।

संशुष्कां भानुतापेन सोऽग्निजार इति स्मृतः ॥ 135

अथ गिरिसिन्दूरम्—

महागिरिषु चाल्पायःपाषाणान्तःस्थितो रसः । 137

अथ हिङ्गुलः—

एतस्मादाहृतः सूतो जोर्णगन्धसमो गुणैः ॥ 141.

दरदः पातनायन्त्रे पातितश्च जलाश्रये ।

तत्सत्त्वं सूतसङ्काशं पातयेन्नात्र संशयः ॥ 144.

अथ मृदारमृङ्गकम्—

सदलं पीतवर्णं च भवेद्गुर्जरमण्डले ।

अर्बुदस्य गिरेः पार्श्वे जातं मृदारमृङ्गकम् ॥

सीससत्त्वं गुरु श्लेष्मशमनं पुंगदापहम् ।

रसबन्धनमुत्कष्टं केशरञ्जनमुत्तमम् ॥

साधारणरसाः सर्वे मातुलुङ्गार्द्रकाश्विना ।

त्रिरात्रं भाविताः शुष्का भवेयुर्दोषवर्जिताः ॥

अथ राजावर्त्तः—

राजावर्त्तोऽल्परक्तोरुनीलिममिश्रितप्रभः<sup>1</sup> । 149.

लुङ्गाम्बुगन्धकोपेतो राजावर्त्तो विचूर्णितः ।

पुटनाक्षसवारिण राजावर्त्तो मृतो भवेत् ॥ 153.

अथ चतुर्थोऽध्यायः ।

अथ रत्नानि ।

मणयः—

मणयोऽपि च विज्ञेयाः सूतबन्धस्य कारकाः ।

वैक्रान्तः सूर्यकान्तश्च हीरकं मौक्तिकं मणिः ॥

चन्द्रकान्तस्तथा चैव राजावर्त्तश्च सप्तमः ।

गरुडोद्गारकश्चैव ज्ञातव्या मणयस्त्वमी ॥

(1) नीलिममिश्रितप्रभः, another reading in the Poona ed., which agrees with B. and K., but it is grammatically inaccurate.

पुष्परागं महानीलं पद्मरागं प्रबालकम् ।

वैदूर्यं च तथा नीलमेते च मणयो मताः ॥

1 3.

अथ वज्रम्—

वज्रं च त्रिविधं प्रोक्तं नरो नारी नपुंसकम् ।

पूर्वं पूर्वमिह श्रेष्ठं रसवीर्यविपाकतः ॥ 26.

अष्टास्रं चाष्टफलकं षट्कोणमतिभासुरम् ।

अम्बुदेन्द्रधनुर्वारितरं पुंवज्रमुच्यते ॥ 27.

तदेव चिपिटाकारं स्त्रीवज्रं वर्तुलायतम् ।

वर्तुलं कुण्डकोणाय किञ्चिद्गुरु नपुंसकम् ॥ 28.

श्वेतादिवर्णभेदेन तदेकैकं चतुर्विधम् ।

ब्रह्मक्षत्रियविट्शूद्रं स्वस्ववर्णफलप्रदम् ॥ 30.

आयुःप्रदं भटिति सङ्गुणदं च वृथं

दोषत्रयप्रशमनं सकलामयघ्नम् ।

सूतेन्द्रबन्धवधसङ्गुणकृत् प्रदीपं

मृत्युञ्जयं तदमृतोपममेव वज्रम् ॥ 32.

कुलत्यक्तायके स्त्रियं कोद्रवक्षयितेन वा ।

एकयामावधि स्त्रियं वज्रं शुध्यति निश्चितम् ॥

वज्रं मत्कुणरक्तेन चतुर्वारं विभावितम् ।  
 सुगन्धिमूषिकामांसैर्वर्तितैः परिवेष्ट्य च<sup>1</sup> ॥  
 पुटेत् पुटैर्वराहाख्यैस्त्रिंशद्वारं ततः परम् ।  
 धात्वा धात्वा शतं वारान् कुलत्थक्काथके क्षिपेत् ॥  
 अन्यैरुक्तः शतं वारान् कर्त्तव्योऽयं विधिक्रमः ॥ 34-37.  
 कुलत्थक्काथसंयुक्तलकुचद्रवपिष्टया ।  
 शिलया लिप्तमूषायां वज्रं क्षिप्त्वा निरुध्य च ।  
 अष्टवारं पुटेत् सम्यग्विशुष्कैश्च वनोपलैः ।  
 शतवारं ततो धात्वा निक्षिप्तं शुद्धपारदे ।  
 निश्चितं म्रियते वज्रं भस्म वारितरं भवेत् ॥ 38-39.  
 सत्यवाक् सोमसेनानीरेतद्वज्रस्य मारणम् ।  
 दृष्टप्रत्ययसंयुक्तमुक्तवान् रसकौतुकी ॥ 40.  
 विलिप्तं मत्कुणस्यास्त्रे सप्तवारं विशोषितम् ॥  
 कासमर्दरसापूर्णे लोहपात्रे निवेशितम् ।  
 सप्तवारं परिधातं वज्रभस्म भवेत् खलु ॥  
 ब्रह्मज्योतिर्मुनीन्द्रेण क्रमोऽयं परिकीर्तितः । 41-43

(1) परिवेष्ट्य च, another reading in the Poona ed. which does not agree with B. and K.

मदनस्य फलोद्भूतरसेन क्षौणिनागकैः ।

कृतकल्केन संलिप्य पुटेद्विंशतिवारकम् ॥

वज्रचूर्णं भवेद्वर्णं योजयेच्च रसादिषु ॥ 44 45.

अथ रत्नभस्मक्रमः—

लकुचद्रावसंपिष्टैः शिलागन्धकतालकैः ।

वज्रं विनान्यरत्नानि म्रियन्तेऽष्टपुटैः खलु ॥ 63.

रामठं पञ्चलवणं क्षाराणां त्रितयं तथा ।

मांसद्राव्यास्त्रवेतश्च<sup>1</sup> चूलिकालवणं तथा ॥

स्थूलं कुम्भीफलं पक्वं तथा ज्वालामुखी शुभा ।

द्रवन्ती च रुदन्ती च पयस्या चित्रमूलकम् ॥

दुग्धं स्नुह्यास्तथार्कस्य सर्व्वं संमर्द्य यत्नतः ।

गोलं विधाय तन्मध्ये प्रक्षिपेत् तदनन्तरम् ॥

गुणवन्नवरत्नानि जातिमन्ति शुभानि च ।

भूर्जे तं गोलकं कृत्वा सूत्रेणावेष्ट्य यत्नतः ॥

(1) मांसद्राव्यास्त्रवेतश्च, a variant in the Poona ed., which we have adopted and which also agrees with B. and K.

पुनर्वस्त्रेण संवेष्ट्य दोलायन्त्रे निधाय च ।

सर्वाङ्गयुक्तसन्धानपरिपूर्णघटोदरे ॥

अहोरात्रत्रयं यावत् स्वेदयेत्तीव्रवह्निना ।

तस्मादाहृत्य सङ्गात्थ रत्नजां द्रुतिमाहरेत् ॥ 64-69.

मुक्ताचूर्णन्तु सप्ताहं वेतसान्नेन मर्दितम् ।

जम्बीरोदरमध्ये तु धान्यराशौ विनिक्षिपेत् ॥

सप्ताहादुद्धृतञ्चैव पटे दत्त्वा द्रुतिं हरेत् ॥ 70-71.

वज्रवज्रान्तरस्थञ्च कृत्वा वज्रं निरोधयेत् ।

अश्लभाण्डगतं स्वेद्यं सप्ताहाद्भवतां व्रजेत् ॥ 72.

अथ वैक्रान्तम्—

श्वेतवर्णन्तु वैक्रान्तमश्लवेतसभावितम् ।

सप्ताहान्नात्र सन्देहः खरघर्भो द्रवत्यलम् ॥ 73.

केतकीश्वरसो ग्राह्यः सैन्धवं स्वर्णपुष्पिका ।

इन्द्रगोपकसंयुक्तं सर्व्वं भाण्डे विनिक्षिपेत् ॥

सप्ताहं स्वेदयेदस्मिन् वैक्रान्तं द्रवतां व्रजेत् । 74-75.

(1) द्रुतिं हरेत्, a variant in the Poona ed., which we have adopted.

## अथ पञ्चमोऽध्यायः ।

अथ लोहानि ।

अथ हेमगुणाः —

शुद्धं लोहं कनकरजतं भानुलोहाश्मसारं  
पूतीलोहं द्वितयमुदितं नागवङ्गाभिधानम् ।  
मिश्रं लोहं त्रितयमुदितं पित्तलं कांस्यवर्त्तं  
धातुर्लोहे लुह इति मतः सोऽप्यनेकार्थवाची<sup>१</sup> ॥ १.

प्राकृतं सहजं वह्निःसम्भूतं खनिसम्भवम् ।  
रसेन्द्रवेधसञ्ज्ञातं स्वर्णं पञ्चविधं स्मृतम् ॥ २.  
सौख्यं वीर्यं बलं हन्ति रोगवर्गं करोति च ।  
अशुद्धं न मृतं स्वर्णं तस्माच्छुद्धं समाचरेत् ॥ ३.

सुवर्णपत्रं तनु कर्षमानं<sup>२</sup>  
गरावरुद्धं पटुधातुयुक्तम् ।

(1) सोऽप्यनेकार्थवाची, a variant in the Poona ed., which we have adopted.

(2) सुवर्णपत्रं तनु कर्षमानं, another reading in the Poona ed., which we have accepted.

अङ्गारसंस्थं प्रहरार्द्धमानं

धानेन तत् स्यान्ननु पूर्णवर्णम्<sup>1</sup> ॥ 12.

लोहानां मारणं श्रेष्ठं सर्वेषां रसभस्मना ।

मूलीभिर्मध्यमं प्राहुः कनिष्ठं गन्धकादिभिः ॥ 13.

अरिलोहेन लोहस्य मारणं दुर्गुणप्रदम् ।

कृत्वा कण्टकवेध्यानि स्वर्णपत्राणि लेपयेत् ।

लुङ्गाम्बुभस्मसूतेन म्रियते दशभिः पुटैः ॥ 14.

द्रुतं विनिक्षिपेत् स्वर्णे लोहमानं मृतं रसम् ।

विचूर्ण्य लुङ्गतोयेन दरटेन समन्वितम् ॥

जायते कुङ्कुमच्छायं स्वर्णं द्वादशभिः पुटैः ॥

15-16.

हेम्नः पादं मृतं सूतं पिष्टमस्त्वेन केनचित् ।

पत्रे लिप्त्वा पुटैः पाच्यं दशभिः<sup>2</sup> म्रियते ध्रुवम् ॥ 17.

(1) पूर्णवर्णम्. a different reading in the Poona ed., which we have retained

(2) पुटैः पाच्यं दशभिः, a variant in the Poona ed., which we have adopted.

अथ रजतम्—

सहजं खनिसञ्जातं कृत्रिमं च त्रिधा मतम् ॥ 22.

नागेन टङ्गणेनैव वापितं शुद्धिमृच्छति ।

खुर्परे भस्मचूर्णाभ्यां परितः पालिकां चरेत् ॥

तत्र रूष्यं विनिक्षिप्य समसीससमन्वितम् ।

जातमीसक्षयं यावद्धमेत् तावत् पुनः पुनः ॥

इत्थं सशोधितं रूष्यं योजनीयं रसादिषु । 32-34.

लकुचद्रवप्रताभ्यां तारपत्रं प्रलेपयेत् ॥

जड्वाधो गन्धकं दत्वा सूक्ष्ममध्ये निरुध्य च ।

स्वेदयेद्वालुकाग्रजे दिग्जलिकं दृढाग्निना ॥

स्वाङ्गशीतां च तां पिष्टिं साकृतादेन मर्दिताम् ।

पुटेद्वादशवाराणि भस्मीभवति रूष्यकम् ॥

35-37.

मात्लीकचूर्णलुङ्गान्मर्दितं पुटितं शनैः ।

त्रिंशद्वारेण तत् तारं भस्मसाज्जायतेतराम् । 38.

(1) च त्रिधा, another reading in the Poona ed., which also agrees with B. and K.

तारपत्रं चतुर्भागं भागैकं शुद्धतालकम् ।  
 मर्द्यं<sup>1</sup> जम्बीरजद्रावैस्तारपत्राणि लेपयेत् ॥  
 शोषयेदन्यन्त्रे च त्रिंशदुपलकैः पचेत् ।  
 चतुर्दशपुटैरेवं निरुध्यं जायते ध्रुवम् ॥ 40-41

अथ ताम्रम्—

स्नेच्छं नेपालकं चेति तयोर्नेपालमुत्तमम् ।  
 नेपालादन्यखन्युत्थ स्नेच्छमित्यभिधीयते ॥ 44.  
 जम्बीररससंपिष्टरसगन्धकलेपितम् ।  
 शुल्बपत्रं शरावस्थं त्रिपुटैर्याति पञ्चताम् ॥ 55

अथायः—

मुण्डं तीक्ष्णं च कान्तं च त्रिप्रकोरमयः स्मृतम् ।

अथ मुण्डम् —

मृदु कुण्ठं कङ्कारं च त्रिविधं मुण्डमुच्यते ॥ 70.  
 द्रुतद्रावमविस्फोटं चिक्कणं मृदु तच्छुभम् ।  
 हतं यत्प्रसरेद्दुःखात् तत्कुण्ठं मध्यमं स्मृतम् ॥  
 यद्धतं भज्यते भङ्गे कृष्णं स्यात्तत्कङ्कारकम् ॥ 71 72.

(1) 'The' Poona ed. reads मर्द्यं, which is grammatically inaccurate.

अथ तीक्ष्णम्—

\* \* \* षड्विधं तीक्ष्णमुच्यते ॥ 75.

परुषं पीगरोन्मुक्तं भङ्गे पारदवच्छवि ।

नमने भङ्गुरं यत् तत् खरलोहमदाहृतम् ॥ 76

वेगभङ्गुरधारं<sup>1</sup> यत् सारलोहं तदीरितम् । 78.

अथ कान्तम्—

भ्रामकं चुम्बकं चैव कर्षकं द्रावकं तथा ।

एवं चतुर्विधं कान्तं रोमकान्तं च पञ्चमम् ॥

एकद्वित्रिचतुःपञ्चसर्व्वतोमुखमेव तत् ।

पीतं कृष्णं तथा रक्तं त्रिवर्णं स्यात् पृथक् पृथक् ॥

84-85.

भ्रामयेल्लोहजातं तु तत् कान्तं भ्रामकं मतम् ॥

चुम्बयेच्चुम्बकं कान्तं कर्षयेत् कर्षकं तथा ।

साक्षादयद्द्रावयेल्लोहं तत् कान्तं द्रावकं भवेत् ॥

तद्रोमकान्तं स्फुटितादयतो रोमोद्गमो भवेत् ।

88-89.

मदोन्मत्तगजः सूतः कान्तमङ्गुशमुच्यते ॥

(1) The Poona ed. reads वेगभङ्गुरधारम्, which is grammatically inaccurate

नेत्रं खात्वा ग्रहीतव्यं तत्प्रयत्नेन धीमता ।

मारुतातपविक्षिप्तं वर्जयेन्नात्र संशयः ॥ 92-93.

पात्रे<sup>1</sup> यस्य प्रसरति जले तैलबिन्दुर्न क्षिप्तं  
गन्धं हिङ्गु त्यजति च तथा तिक्ततां निम्बकल्कः ।

पात्रं दुग्धं भवति शिखराकारकं<sup>2</sup> नैति भूमिं  
कान्तं लोहं तदिदमुदितं लक्ष्णोक्तं न चान्यत् ॥ 94.

क्षितितं धृतमंयुक्तं क्षिप्वायः खपरं पचेत् ।

चालयेत्क्षौद्रदण्डेन यावत् क्षिप्तं दृढं दहेत् ॥

पिष्टा पिष्टा पचेदेवं पञ्चवारमतः परम् ।

धात्रीफलरसैर्यद्वा त्रिफलाक्रयितोदकैः ।

पुटेक्ष्णाहं चतुर्वारं भवेद्वारितरं खलु ॥ 104-105

(1) Cf. यत्पात्रं न प्रसरति जले तैलबिन्दुः प्रथमे

हिङ्गुर्गन्धं त्यजति च । नञं तिक्ततां निम्बकल्कः ।

तत्रं दुग्धं भवति शिखराकारकं नैति भूमिं

क्षौद्राङ्गं स्यात् सजलचणकः कान्तलोहं तदुक्तम् ॥

भावप्रकाशे कान्तलोहप्रकरणम् ।

(2) A variant in the Poona ed., which agrees with the भावप्रकाश, as quoted in the foot note.

तरेखलोहस्य पत्राणि निर्दलानि दृढेऽनले ।  
 धात्वा क्षिपेज्जले सद्यः पाषाणोलूखलोदरे ॥  
 खण्डयेद्गदादनिर्घातैः स्थूलया लोहपारया ।  
 तन्मध्यात्<sup>१</sup> स्थूलखण्डानि रुद्धा मल्लदयान्तरे ॥  
 धात्वा क्षिप्वा जले सम्यक् पूर्व्ववत् कण्डयेत् खलु ।  
 तच्चूर्णं सूतगन्धाभ्यां पुटेद्विंशतिवारकम् ॥  
 पुटे पुटे विधातव्यं पेषणं दृढवत्तरम् ।  
 एवं भस्मीकृतं लोहं तत्तदरोगेषु योजयेत् ॥

107-110.

जम्बीरैरालनालैर्वा विंशत्यंशेन हिङ्गुलम् ॥  
 पिष्ट्वा रुद्धा पचेन्नोहं तद्वैः पाचयेत् पुनः ।  
 चत्वारिंशत्पुटेरेवं कान्तं तीक्ष्णं च मुण्डकम् ॥  
 म्रियते नात्र सन्देहो दत्त्वा दत्त्वैव हिङ्गुलम् ।

113-115.

शुद्धसूतं द्विधा गन्धं खल्ले तु कृतकज्जलीम् ।  
 द्वयोः समं लोहचूर्णं मर्दयेत् कन्यकाद्रवैः ॥

(1) तन्मध्यात्, a reading in the Poona ed., which also agrees with B. and K.

यामहयात् समुद्धृत्य तद्गोलं ताम्रपात्रके ।  
 आच्छाद्यैरण्डपत्रैश्च यामार्द्धेऽत्युष्णता भवेत् ॥  
 धान्यराशौ न्यसेत् पञ्चात् त्रिदिनान्ते समुद्धरेत् ।  
 संपेथ्य गालयेद्वस्त्रे सत्त्वं वारितरं भवेत् ॥  
 कान्तं तीक्ष्णं च मुण्डं च निरुत्थं जायते ध्रुवम् ।  
 स्वर्णादीन् मारयेदेवं चूर्णं कृत्वा च लोहवत् ॥

134-137.

लोहकिट्टं सुसन्तप्तं यावज्जीर्यति तत् स्वयम् ।  
 तच्चूर्णं जायते पेथ्यं मण्डूरोऽयं प्रयोज्यते ॥ 147.  
 ये गुणा मारिते मुण्डे ते गुणा मुण्डकिट्टके ।  
 तस्मात् सर्वत्र मण्डूरं रोगशान्त्यै प्रयोजयेत् ॥ 148.

अथ वङ्गम्—

खुरकं मिश्रकं चेति द्विविधं वङ्गमुच्यते ।  
 खुरं तत्र गुणैः श्रेष्ठं मिश्रकं न हितं मतम् ॥ 153.  
 धवलं मृदुलं स्निग्धं द्रुतद्रावं सगौरवम् ।  
 निःशब्दं खुरवङ्गं स्यान्मिश्रकं श्यामशुभ्रकम् ॥ 154.

(1) ताम्रपात्रके, a reading in the Poona ed., which also agrees with B. and K.

वङ्गं तिलोष्णकं रुचमीषद्वातप्रकोपनम् ।  
 मेहश्चेक्षामयघ्नं च मेदोघ्नं क्रिमिनाशनम् ॥ 155.  
 द्रावयित्वा निशायुक्ते क्षिप्तं निर्गुणिकारसे ।  
 विशुध्यति त्रिवारेण खुरवङ्गं न संशयः ॥ 156.  
 सतालेनार्कदुग्धेन लिप्ता वङ्गदलान्यथ ।<sup>1</sup>  
 बोधिचिन्तात्वचः चारैर्दद्यात्तप्तपुटानि च ॥  
 मर्हयित्वा चरेद्भस्म \* \* \* ॥ 159-160.

अथ सीसकम्—

द्रुतद्रावं महाभारं छेदे कृष्णसमुज्ज्वलम् ।  
 पूतिगन्धं वह्निःकृष्णं शुद्धं सीसमतोऽन्यथा ॥ 171.  
 पलविंशतिकं नागमधस्तीव्रानलं क्षिपेत् ।  
 द्रुते नागे क्षिपेत् स्रुतं शुद्धं कर्षमितं शुभम् ॥  
 विघट्य निक्षिपेत् चारमेकैकं हि पलं पलम् ।  
 अर्जुनस्नाक्षवृक्षस्य महाराजगिरिरपि ।  
 दाहिमस्य मयूरस्य क्षिप्त्वा चारं पृथक् पृथक् ॥

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(1) वच, a variant in the Poona ed., which also agrees with B. and K.

एवं विंशतिरात्राणि पचेत् तीव्रेण वज्रिणा ।  
 विघट्टयन् दृढं दोर्भ्यां लोहद्वयां प्रयत्नतः ॥  
 रत्नं तज्जायते भस्म कपोतच्छायमेव वा ।

176 179.

शिलया रविदुग्धेन नागपत्राणि लेपयेत् ॥  
 मारयेत् पुटयोगेन निरुध्यं जायते तथा । 184-185.

अथ पित्तलम्—

रीतिका काकतुण्डी च द्विविधं पित्तलं भवेत् ।  
 सन्तप्ता काष्ठीके क्षिप्ता ताम्बाभा रीतिका मता ॥  
 एवं या जायते कृष्णा काकतुण्डीति सा मता ॥

192-193.

गुर्वी मृद्धी च पीताभा साराङ्गी ताडनक्षमा ।  
 सुस्निग्धा मसृणाङ्गी च रीतिरेतादृशी शुभा ॥ 195.  
 पूतिगन्धा तथा लघ्वी रीतिर्नेष्टा रसादिषु ॥ 196.  
 निम्बूरसशिलागन्धवेष्टिता पुटिताष्टधा ।  
 रीतिरायाति भस्मत्वं ततो योज्या यथायथम् ॥  
 ताम्रवन्मारणं तस्याः कृत्वा सर्व्वं च योजयेत् ।

201; 202.

अथ कांस्यम्—

अष्टभागेन ताम्रेण द्विभागकुटिलेन च ।

विद्रुतेन भवेत् कांस्यं \* \* \* ॥ 205.

म्रियते गन्धतालाभ्यां निरुत्यं पञ्चभिः पटैः ॥ 210.

अथ वर्तलोहम्—

कांस्यार्करीतिखोहाहिजातं तद्वर्तलोहकम् ।

तदेव पञ्चलोहाख्यं लोहविद्रुतदाहृतम् ॥ 212.

म्रियते गन्धतालाभ्यां पुटितं वर्तलोहकम् । 216.

अथ षष्ठोऽध्यायः ।

अथ शिखोपनयनम् ।

आचार्यो ज्ञानवान् दक्षो रसशास्त्रविशारदः ।

मन्त्रसिद्धो महाधीरो निश्चलः शिववत्सलः ॥

देवीभक्तः सदाधीरो देवतायागतत्परः ।

सर्वाङ्गायविशेषज्ञः कुशलो रसकथंश्चि ॥

एवं लक्ष्मणसंयुक्तो रसविद्यागुरुर्भवेत् ।  
 गुरुभक्ताः सदाचाराः सत्त्ववन्तो दृढव्रताः ॥  
 निरालस्याः स्वधर्मज्ञाः सदाग्रापरिपालकाः ।  
 दम्भमात्सर्यनिर्मुक्ताः कुलाचारेषु दौक्षिताः ॥  
 अत्यन्तसाधकाः शान्ता मन्त्राराधनतत्पराः ।  
 इत्येवं लक्ष्मणैर्युक्ताः शिष्याः स्युः कार्यसिद्धये ॥<sup>3-7</sup>  
 आतङ्करहिते देशे धर्मराज्ये मनोरमे ।  
 उमामहेश्चरोपेते समृद्धे नगरे शुभे ॥ ०  
 कर्त्तव्यं साधनं तत्र रसराजस्य धीमता ।  
 अत्यन्तोपवने रम्ये चतुर्हारीपशोभिते ॥  
 तत्र शाला प्रकर्त्तव्या सुविस्तीर्णा मनोरमा ।  
 सम्यग्वातायनोपेता दिव्यचित्रैर्विचित्रिता ॥

13-15.

निष्कचयं हेमपत्रं रसेन्द्रं नवनिष्ककम् ।  
 अक्षेण मर्दयेद्यामं तेन लिङ्गं तु कारयेत् ॥  
 तल्लिङ्गं पूजयेत् तत्र शुभैरुपचारकैः ॥  
 लिङ्गकोटिसहस्रस्य यत् फलं सम्यगर्चनात् ।  
 तत् फलं कोटिगुणितं रत्नलिङ्गार्चनात्प्रभवेत् ॥

ब्रह्महत्यासहस्राणि स्त्रोगोहत्यायुतानि<sup>1</sup> च ।  
तत्त्वचाद्विलयं यान्ति रससिद्धयश्च दर्शनात् ॥

19-22.

रसविद्या<sup>2</sup> शिवेनीता दातव्या साधकाय वै ।  
यद्योक्तेन विधानेन गुरुणा मुदितात्मना ॥ 30.

कोष्ठी मूषा वङ्गनाली तुषाङ्गारबनोपलाः ॥  
भस्त्रिका दण्डिकानेकाः शिलाखलान्युलूखलम् ।

\* \* \* \* \*

अनेन मूलमन्त्रेण भैरवं तत्र पूजयेत् ।  
सर्वेषां रससिद्धानां नाम सङ्कीर्तयेत्तदा ॥

\* \* \* \* \*

सप्तविंशतिसंख्याका रससिद्धिप्रदायकाः ।  
वन्द्याः पूज्याः प्रयत्नततः कुप्यादुरसार्चनम् ॥

52-61.

(1) स्त्रोगोहत्यायुतानि च, a variant in the Poona ed., which we have adopted.

(2) B. and K. read रसदीपा ।

हर्षयेद्विजटेवानां तर्पयेदिष्टदेवताः ।

कुमारीयोगिनीयोगीश्वरान् स्नेच्छकसाधकान्<sup>1</sup> ॥

62.

रसविद्या दृढं गोप्या मातुर्गुह्यमिव ध्रुवम् ।

भवेद्दवीर्य्यवती गुप्ता निर्वीर्य्या च प्रकाशनात् ॥<sup>70</sup>.

## अथ सप्तमोऽध्यायः ।

अथ रसशाला ।

रसशालां प्रकुर्व्वीत सर्व्वबाधाविवर्ज्जिताम् ।

सर्व्वौषधमये देशे रम्यकूप-समन्विते ॥

नानोपकरणोपेतां प्राकारेण सुशोभिताम् ॥

शालायाः पूर्व्वदिग्भागे स्थापयेदरसभैरवम् ।

वह्निकर्त्तव्याणि चान्धेये याम्ये पाषाणकर्त्तव्यं च

(1) स्नेच्छकसाधकान्, a variant in the Poona ed., which also agrees with B.

(2) रम्यकूप, a variant in the Poona ed., which we have adopted.

नेर्कृत्ये शस्त्रकर्माणि वारुणे क्षालनादिकम् ।  
 शोषणं वायुकोषे च वेधकर्मास्तरे तथा ॥  
 स्थापनं सिद्धवस्तूनां प्रकुर्यादौशकोषके ।  
 पदार्थसङ्ग्रहः कार्य्यौ रससाधनहेतुकः ॥  
 सस्वपातनकोष्ठीश्च सुराकोष्ठीं सुशोभनाम् ।  
 भूमिकोष्ठीं चलत्कोष्ठीं जलद्रोणीरनेकशः ॥  
 भस्त्रिकायुगलं तद्वक्त्रलिके वंशलोहयोः ।

\* \* \* \* \*

करणानि विचित्राणि द्रव्याण्यपि समाहरेत् ।  
 कण्डूनीं पेषणीं खल्लान् द्रोणीरूपांश्च वर्तुलान् ।  
 सूक्ष्मच्छिद्रसहस्राभ्यां द्रव्यगालनहेतवे ।  
 क्षालनीश्च कटचाणि \* \* \* ॥  
 मूषानृत्तुषकार्पासवनोपलकपिष्टकम् ।  
 काचायोमृद्वराटानां कूपिकाचषकानि च । 1-18.  
 निर्लोभाः सत्यवक्तास्तरो देववाङ्मणपूजकाः ।  
 यमिनः पथ्यभोक्तारो योजनीया रसायने ॥ 30.  
 तत्तदौषधनामज्ञाः शुचयो वञ्चनोज्झिताः ।  
 नानाविषयभाषाज्ञास्ते मता भेषजाहृतौ ॥ 32.

## अथ अष्टमोऽध्यायः ।

अथ परिभाषा ।

कथ्यते सोमदेवेन मुम्भवेत्यप्रवृत्तये ।

परिभाषा रवेन्द्रस्य शास्त्रीः सिद्धैव भाषिता ॥ 1.

अर्धं सिद्धरसस्य तैलघृतयोर्लोहस्य भागोऽष्टमः

संसिद्धाखिललोहचूर्णवटकादीनां तथा सप्तमः ।

यो दीयेत भिषग्बराय गदिभिर्निर्दिष्टं धन्वन्तरिं

सर्वारोग्यसुखामये निगदितो भागः स धन्वन्तरेः ॥ 2.

धातुभिर्गन्धकाद्यैश्च निर्द्रवैर्मर्दितो रसः

सुश्लक्ष्णः कज्जलाभोऽसौ कज्जलीत्वंभिधीयते ॥

सद्रवा मर्दिता सैव रसपट्ट इति स्मृतः ॥ 5-6.

मृतं तरति यत्तोये लोहं वारितरं हि तत् ।

अद्भुततर्जनीघृष्टं यत्तदरेखान्तरं<sup>1</sup> विशेत् ॥

मृतं लोहं तदुद्दिष्टं रेखापूर्णाभिधानतः ॥

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(1) रेखान्तरं, a variant in the Poona ed. which we have adopted.

गुह्यगुह्यासुखस्पर्शमध्वाज्यैः<sup>1</sup> सह योजितम् ।  
 नायाति प्रकृतिं धानादपुनर्भवमुच्यते ॥  
 तस्मिन्परि गुह्यं द्रव्यं धान्यं चोपनयेद्भुवम् ।  
 हंसवत् तीर्यते वारिष्युत्तमं परिकीर्तितम् ॥

25-28.

रौप्येण सह संयुक्तं धातं रौप्ये<sup>2</sup> न चेन्नगेत् ।  
 तदा निरत्यमित्युक्तं लोहं तदपुनर्भवम् ॥ 29.  
 तीक्ष्णं नीलाञ्जनोपेतं धातं हि बहुशो दृढम् ।  
 मृदुलक्षणं द्रुतद्रावं वरनागं<sup>3</sup> तदुच्यते ॥ 38.

- (1) Cf. घृतमधुगन्नाटकेः ममं लोहमस्य मदयेच्च विचक्षणः ।  
 धर्मद्रवज्ञौ यदा पुनर्लोहभावं न गच्छेत् तदा योज्यं रसायने ॥  
 लोहभावं यदा गच्छेत् तं पुनर्नारयेत् सुधीः ।

रसचन्द्रिका जारणमारणाध्यायः ।

(2) We have adopted the reading in B. and K. The Poona ed., however, reads रौप्ये च चेन्नगेत्, which, from the chemical point of view, is untenable.

(3) वरनागं, a variant in the Poona ed., which also agrees with B.

सूतस्य पुनरुद्भूतिः सम्प्रोक्तोत्थापनाख्यया । 39.

इयन्मानस्य सूतस्य भोज्यद्रव्यात्मिका मतिः ।

इयतीत्युच्यते यासौ ग्रासमानमितीरितम् ॥ 64.

चतुःषष्ट्यंशतो बीजप्रक्षेपो मुखमुच्यते ।

एवङ्कते रसो ग्रासलोलुपो मखवान् भवेत् ॥

कठिनाद्यपि लोहानि क्षमो भवति भक्षितुम् । 68-69.

लेपः क्षेपश्च कुन्तश्च धूमाख्यः शब्दसंज्ञकः ।

लेपेन कुरुते लोहं स्वर्णं वा रजतं तथा ॥ 80.

वज्रौ धूमायमानेऽन्तः प्रक्षिप्तसधूमतः

स्वर्णाद्यापादनं लोहे धूमवेधः स ईरितः ॥ 83.

मुखस्थितरसेनाल्पलोहस्य दमनात् खलु ।

स्वर्णरूप्यत्वजननं शब्दवेधः स कीर्तितः ॥ 84.

रसनिगममहाब्धेः सोमदेवः समन्तात्

स्फुटतरपरिभाषानामरत्नानि ह्रत्वा ।

अथचयदतियत्नात् तैरिमां कण्ठमालां

कलयतु <sup>1</sup> भिषगग्रो मण्डनार्थं सभायाम् ॥ 89.

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(1) कलयतु, another reading in the Poona ed., which we have adopted.

## अथ नवमोऽध्यायः ।

अथ यन्त्राणि ।

अथ यन्त्राणि वक्ष्यन्ते रसतन्त्राण्यशेषतः ।

समालोक्य समासेन सोमदेवेन साम्प्रतम् ॥ 1.

अथ दोलायन्त्रम्—

द्रवद्रव्येण भाण्डस्य पूरितार्द्धोदरस्य च ।

मुखमुभयतो हारद्वयं कृत्वा प्रयत्नतः ॥ 3.

तयोस्तु निक्षिपेद्दण्डं तन्मध्ये रसपोटलीम् ।

बद्धा तु स्वेदयेदेतद्दोलायन्त्रमिति स्मृतम् ॥ 4.

अथ स्वेदनीयन्त्रम्—

सान्द्रस्थालीमुखाबद्धे वस्त्रे पाक्यं निवेशयेत् ।

पिधाय पच्यते यत्र स्वेदनीयन्त्रमुच्यते ॥ 5.

अथ पातनायन्त्रम्—

अष्टाङ्गुलपरिणाहमानाहेन दशाङ्गुलम् ।

चतुरङ्गुलकीलेधं तोयाधारं गलादधः ॥

अधोभाण्डे मुखं तस्य भाण्डस्योपरिवर्त्तिनः ।

पोडशाङ्गुलविस्तीर्णं पृष्ठस्यास्ये प्रवेशयेत् ॥

पार्श्वयोर्महिषीक्षीरचूर्णमण्डूरफाक्षितैः ।

लिप्ता विशोषयेत् सन्धिं जलाधारे जलं क्षिपेत् ।

चुल्लगामारोपयेदेतत् पातनायन्ममीरितम् ॥ 6-8.

अथाधःपातनायन्मम्—

अथोर्ध्वभाजने<sup>1</sup> लिप्तं स्थापितस्य जले बुधीः ।

दीप्तैर्वनोपलैः कुर्यादधःपातं प्रयत्नतः ॥ 9.

अथ दीपिकायन्मम्—

कण्टपयन्वान्तर्गतमृन्मयपीठस्यदीपिकासंखः ।

यस्मिन्निपतति सूतः प्रोक्तं तद्दीपिकायन्मम् ॥ 10.

अथ ढेकीयन्मम्—

भाग्यकण्ठादधश्छिद्रे वेणुनालं विनिक्षिपेत् ।

कांस्यपात्रद्वयं कृत्वा सम्युटं जलगर्भितम् ॥

नलिकास्यं तत्र योज्यं दृढं तच्चापि कारयेत् ।

युक्तद्रव्यैर्विनिक्षिप्तः पूर्व्वं तत्र घटे रसः ।

अग्निना तापितो नालात्तोये तस्मिन् पतत्स्वधः ॥

यावदुष्णं भवेत्स्वर्भ्यं भाजनं तावदेव हि ।

जायते रससम्भानं ढेकीयन्ममितीरितम् ॥ 11-14.

(1) K. reads अथ, which we have retained.

अथ बालुकायन्त्रम्—

सरसां गूढवक्त्रां मृद्वस्त्राङ्गुलघनावृताम् ।  
 शीघ्रितां काचकलसीं पूरयेत् त्रिषु भागयोः ॥  
 भाण्डे वितस्तिगन्धीरे बालुका सुप्रतिष्ठिता ।  
 तद्भाण्डं पूरयेत् त्रिभिरन्याभिरवगुण्ठयेत् ॥  
 भाण्डवक्त्रं माषिकया सन्धिं लिम्पेन्मृदा पचेत् ।  
 चुम्ब्यां दृश्यन् चादाहान्यणिकापृष्ठवर्तिनः ॥  
 एतद्दि बालुकायन्त्रं तद्यन्त्रं लवणाययम् ॥<sup>34-36.</sup>

अथ लवणयन्त्रम्—

एवं लवणनिक्षेपात् प्रोक्तं लवणयन्त्रकम् । <sup>38.</sup>

अथ नालिकायन्त्रम्—

लोहनास्रगतं सूतं भाण्डे लवणपूरिते ।  
 निरुद्धं विपचेत् प्राम्बनालिकायन्त्रमीरितम् ॥ <sup>41</sup>

अथ तिर्यक्पातनयन्त्रम्—

क्षिपेद्दूरसं घटे दीर्घनताधोनालसंयुते ।  
 तन्नालं निक्षिपेदन्वघटकुण्डलन्तरे खलु ॥

(1) दीर्घनताधो, a variant in the Poona ed., which also agrees with B. and K.

तत्र रुद्धा मृदा सम्यग्वदने घटयोरधः ।  
 अधस्तादरसकुम्भस्य ज्वालयेत् तीव्रपावकम् ॥  
 इतरस्मिन् घटे तोयं प्रक्षिपेत् स्वादुग्भीतलम् ।  
 तिर्यक्पातनमेतद्धि वार्त्तिकैरभिधीयते ॥ 48-50.

अथ हिङ्गुलाकृष्टिविद्याधरयन्त्रम्—

स्थालिकोपरि विन्यस्य स्थालीं सम्यङ्निरुध्य च ।  
 जर्द्वस्थाल्यां जलं क्षिप्त्वा वज्रं प्रज्वालयेदधः ॥  
 एतद्विद्याधरं यन्त्रं हिङ्गुलाकृष्टिहेतवे ॥ 57-58.

अथ धूपयन्त्रम्—

विधायाष्टाङ्गुलं पात्रं लौहमष्टाङ्गुलोच्छ्रयम् ।  
 कण्ठाधो द्व्यङ्गुले देशे गलाधारे हि तत्र च ॥  
 तिर्यग्लोहशलाकाश्च तन्वीस्तिर्यग्विनिक्षिपेत् ।  
 तनूनि स्वर्णपत्राणि तासामुपरि विन्यसेत् ॥  
 पात्राधो निक्षिपेद्धूमं वक्ष्यमाणमिहैव हि ।  
 तत् पात्रं न्युजपात्रेण ष्छादयेदपरिण हि ॥  
 मृदा विलिप्य सन्धिं च वज्रं प्रज्वालयेदधः ।  
 तेन पत्राणि कृत्स्नानि<sup>1</sup> इतान्युक्तविधानतः ॥

(1) कृत्स्नानि, another reading in the Poona ed., which we have accepted.

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गन्धालकशिलानां हि कञ्जल्या वा मृताहिना ॥  
 धूपनं स्वर्णपत्राणां प्रथमं परिकीर्तितम् ।  
 ताराथं तारपत्राणि मृतवज्रेण धूपयेत् ॥  
 धूपयेच्च यथायोग्यैरन्यैरुपरसैरपि ।  
 धूपयन्ममिदं प्रोक्तं जारणाद्रव्यसाधनम् ॥ 70-76.

### अथ दशमोऽध्यायः ।

अथ मूषादिकथनम् ।

मृत्तिका पाण्डुरस्थूला शर्करा शोणपाण्डुरा ।  
 चिराद्भानसहा सा हि मूषार्थमतिशस्यते ॥  
 तदभावे हि वाल्मीकी कौशाली वा समीर्यते ॥  
 या मृत्तिका दग्धतुषैः शण्डेन  
 शिखिचकैर्वा हयलहिना च ।  
 लोहेन दण्डेन च कुट्टिता सा  
 साधारणी स्यात् खलु मूषिकार्थम्<sup>1</sup> ॥ 5-6.

(1) साम् and मूषिकार्थं are two different readings in the Poona ed., which we have adopted.

अथ पुटानि—

लोहाटेरपुनर्भावो गुणाधिक्यं ततोऽप्यता ।  
 अमपु मज्जनं रेखापूर्णता पुटतो भवेत् ॥ 51.  
 निम्ने विस्तरतः कुण्डे द्विहस्ते चतुरस्रके ।  
 वनोपलसहस्रेण पूरिते पुटनौषधम् ॥  
 कोष्ठ्यां<sup>1</sup> रुद्धं प्रयत्नेन पिष्टिकोपरि निक्षिपेत् ।  
 वनोपलसहस्राक्षं कोष्ठिकोपरि विन्यसेत् ॥  
 वज्रं प्रज्वालयेत् तत्र महापुटमिदं स्मृतम् । 54-56.  
 सुवर्णं रजतं ताम्रं चपु सीसकमायसम् ।  
 षडेतानि च लोहानि कृत्रिमे कांक्षपित्तले ॥ 70.  
 लवणानि षडुच्यन्ते सामुद्रं सैन्धवं विडम् ।  
 सौवर्चलं रोमकं च चूलिकालवणं तथा ॥  
 चारचयं समाख्यातं यवसर्जिकटङ्गचम् ॥ 71.

जम्बूकमण्डूकवसा वसा कच्छपसन्धवा ।

(1) कोष्ठ्या, a variant in the Poona ed., which we have adopted.

कर्कोटी विद्युमारी च गोशूकरनरोद्धवा ।  
 चण्डोद्धरमिवाणां महिषस्य वसा तथा ॥ 76 7-7.  
 मूनादि इक्षिकरभमहिषीधरवाजिनाम् ।  
 मोऽजाबीनां स्त्रियः पुंसां पुत्र्यं वीर्यं तु योजयेत् ॥  
 78.

चाङ्गेरीचक्षकाक्षं च अम्बिकं कोलदाडिमम् ।  
 अम्बुष्ठा तिल्लिङ्गीकं च नारङ्गं रसपत्रिका ।  
 करवन्दं तथा चान्यदम्बवर्गः प्रकीर्तितः ॥  
 चक्षकाक्षस्य सर्वेषामेक एव प्रशस्यते ॥  
 अम्बुवेतसमेकं वा सर्वेषामुत्तमोत्तमम् ।  
 रसादीनां विशुद्ध्यर्थं द्रावणे जारणे हितम् ॥  
 कोलदाडिमवृक्षाक्षपुष्पिकाचुक्रिकारसम् ।  
 पञ्चाङ्गकं समुद्दिष्टं तच्चोक्तं चान्नपञ्चकम् ॥  
 80-84.

इष्टिका गैरिका लोचं भस्म वल्लीकमृत्तिका ।  
 रसप्रयोगकुशलैः कीर्तिताः पञ्च मृत्तिकाः ॥ 85.  
 मृद्गीकं कालकूटं च वस्त्रनाभं सङ्गचिमम् ।  
 पित्तं च विषवर्गोऽयं स वरः परिकीर्तितः ॥ 86.

लाङ्गली विषमुष्टिश्च करवीरजटा तथा ।  
 नलिकः कनकोऽर्कश्च वर्गो ह्युपविषात्मकः ॥ 88.  
 गुडगुग्गुलुगुञ्जाण्यसारघैष्टङ्गान्वितैः ।  
 दुर्द्रावाखिललोहादेर्द्रावणाय गणो मतः ॥ 100.

### अथैकादशोऽध्यायः ।

अथ रसशोधनादिकथनम् ।

रसार्णवादिशास्त्राणि निरीक्ष्य कथितं मया ।  
 रसोपयोगि यत्किञ्चिद्दिक्षाचं तत्प्रदर्शितम् ।  
 अधुना रसराजस्य संस्कारान् सम्प्रचक्ष्महे ॥ 10.  
 विषं वक्त्रिर्मलमेति दोषा नैसर्गिकास्ययः ।  
 योगिकौ नागवङ्गौ हौ \* \* \* ॥ 14-15.  
 तस्मात् सूतविधानार्थं सहायैर्निपुणैर्युतः ।  
 सर्वोपस्कारमादाय रसकर्षं समाचरेत् ॥ 20.  
 हे सहस्रे पसानां तु सहस्रं शतमेव वा ।

षष्टाविंशत् पलान्यैः पञ्चैकमेव वा ॥

पलाहेनैव कर्तव्यः स एकस्य च ।

सुदिने शुभनक्षत्रे रसशोधः ॥ 2122.

रसस्य पादांशसुवर्णजः ।

पिष्टीकृतो गन्धकयोगतः ।

तुल्यांशगन्धैः पुटितः क्रमेण

निर्वीजनामा सकलामयघ्नः ॥ 72.

पिष्टीकृतैरभ्रकसस्वहेम-

तारार्ककान्तैः परिजारितो यः ।

हतस्त्वतः षड्गुणगन्धकेन

स बीजबद्धो विपुलप्रभावः ॥ 73.

काकोदुम्बरिकाया दुग्धेन सुभावितो हिङ्गुः ।

मर्दनपुटेन विधिना सूतं भस्मीकरोत्येव ॥ 111.

देवदालीं हरिक्रान्तामारनालेन पेषयेत् ।

तद्वैः सप्तधा सूतं कुर्यान्मर्दितमूर्च्छितम् ॥

तत्सूतं खर्परे दद्याद्दत्त्वा दत्त्वा तु तद्वपम् ।

सुक्ष्मपरि पचेच्चाक्ला भस्म स्यात्तवणोपमम् ॥

अपामार्गस्य बीजानि तथैरण्डस्य चर्षयेत् ।

तच्च र्णं पारदे देयं मूत्रायामधरोत्तरम् ॥

वृद्धः लघुपुटैः पञ्चाशत्तुभिर्भस्मतां नयेत् । 114-115.

# A HISTORY OF HINDU CHEMISTRY

*Volume-II*



# **HISTORY OF HINDU CHEMISTRY**

**FROM**

***THE EARLIEST TIMES TO THE MIDDLE OF THE  
SIXTEENTH CENTURY A D***

**WITH**

**SANSKRIT TEXTS, VARIANTS, TRANSLATION  
AND ILLUSTRATIONS**

**BY**

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***Professor of Chemistry, Presidency College, Calcutta***

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## PREFACE

The second and concluding volume of the *History of Hindu Chemistry* is now presented to the public.

When the first volume was under preparation, it was feared that many valuable works on Hindu Chemistry referred to in *Rasārṇava*, *Rasaratna-samuchchaya*, *etc.*, had been lost for ever. Pandit Navakānta Kavibhūṣana was deputed to Benares to make a searching enquiry and his labours have been rewarded by the discovery of several rare MSS., including one of *Rasahrīdaya*. This last-named work is of surpassing interest considering its comprehensiveness and antiquity. Two more transcripts of it have also been procured from the Libraries of the India Office, London, and of the Darbār, Nepal. A copy of *Rasendra-chūdāmāni* obtained from the Library of the Deccan College, Poona, has also been of signal help. A critical study of the new materials throws a flood of light on the dark recesses of the history of Indian Chemistry. As a halo of literary and scientific activity including the pursuit of alchemy circles round the prominent figure of Nāgārjuna, considerable space has been devoted to a discussion of his age in the Historical Introduction.

It was with diffidence and hesitation that I placed the remotest limit of alchemical *Tantras* in the 10th century A. D. It now transpires that this date is to be pushed back by several centuries.

A *History of Hindu Chemistry* would be rightly regarded as incomplete which did not deal with the constitution of matter and the various hypotheses in regard to it. The European historian of chemistry has always turned his eyes to Greece as the perennial fountain of knowledge on this as on other subjects. And it is but natural that he should do so. \* The Hindu atomistic school has not hitherto, I am afraid, found an interpreter who could do full justice to it. Colebrooke's presentation of it with which I had to content myself in the first volume is masterly so far as it goes, but is fragmentary. Not feeling myself equal to the task I applied for help to Mr. Brajendra Nâth Seal Principal, Victoria College, Cooch Behar. Principal Seal has kindly responded to my appeal with alacrity. It is to be hoped that a long-felt *desideratum* has at last been supplied.

The frequent references which have been made to the first volume must be taken to mean the second edition of it. Those who happen to possess copies of the first edition will not, however, be put to any serious inconvenience.

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\* *Vide* Vol. 1. Intro. xliii.

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I avail myself of this opportunity to express my cordial thanks to Pandit Harischandra Kavi-ratna late Professor of Sanskrit, Presidency College, and my collaborator in the editing of the text of *Rasārṇava* in the *Bibliotheca Indica* series.

In the preface to the first volume I presumed to narrate the circumstances under which I undertook the composition of my History. The great chemist and savant, whose inspiration has been my guiding principle throughout the arduous task and whose lengthy and appreciative review of the first instalment has been a stimulus in the continuation of it is no more. Marcellin Berthelot breathed his last on March 18, 1907, leaving the world of science poor indeed. It was with the view of coming into personal contact with the illustrious scientist that the author made a pilgrimage to Paris in March, 1905. The long interview which he had with M. Berthelot and the reception which was accorded to him at a meeting of the Academy of Sciences by its late Perpetual Secretary, as also by its President M. Troost, made a deep and lasting impression on his mind.

Alas, for the vanity of human wishes ! These pages will no longer be greeted by the eager and indulgent eyes of M. Berthelot. All that now remains for me is to dedicate this volume to his sacred memory.

~~~~~

It is with mingled feelings that I mark the hour of my final deliverance from a self-imposed task which has occupied all my spare time during the last 15 years and more—feelings not unlike those which overpowered the Historian of the Roman Empire. The reader will, I hope, forgive me if I venture to give expression to them in the words of Edmund Gibbon himself. “I will not dissemble the first emotions of joy on the recovery of my freedom. * * * But my pride was soon humbled, and a sober melancholy was spread over my mind, by the idea that I had taken an everlasting leave of an old and agreeable companion.”

The Hindu nation with its glorious past and vast latent potentialities may yet look forward to a still more glorious future, and, if the perusal of these pages will have the effect of stimulating my countrymen to strive for regaining their old position in the intellectual hierarchy of nations, I shall not have laboured in vain.

PRESIDENCY COLLEGE

P. C. RAY

June 1, 1909.

PRELIMINARY REMARKS ON THE MECHANICAL, PHYSICAL AND CHEMICAL THEORIES OF THE ANCIENT HINDUS.

My paper on the *Mechanical, Physical and Chemical Theories of the Ancient Hindus* is intended to be a synoptic view of the entire field of Hindu Physico-chemical Science, so far as this reached the stage of positive Science as distinguished from the prior mythological and empirical stages. As the work in which my paper appears relates to Hindu Chemistry, I have elaborated the chemical portions, including the Hindu account of the constitution of the fats and oils and the organic tissues in addition to Hindu inorganic chemistry. I have also briefly noticed the chief chemical industries of the Hindus which secured them an easy pre-eminence in manufactures for a thousand years, and, in the *Addenda*, given some interesting recipes relating to several matters of chemical technology. Of mechanico-physical theories, I have expounded the Hindu conception of Energy, potential as well as kinetic, and of molecular motion, so far as they are applied to the elucidation of problems of a physico-chemical nature, viz., the constitution of

matter, the genesis of atoms and their infra-atomic constituents, and the chain of mechanical causation in the system of Nature. I have also touched on the Hindu theories of light, heat and sound, as implying current or wave motion, leaving the elaborate exposition to my paper on Hindu Mechanics and Physics. In the *Appendix*, I have added a brief account of the Scientific Method of the Hindus, which shows that all this was not a mass of unverified and unverifiable speculation (the very antipodes of science),—the charge usually brought against Hindu thought and culture,—but professed to be the outcome of a Scientific Methodology which, in its formulation of the canons of the two fundamental Inductive Methods, is more comprehensive as well as more original and suggestive than Mill, and which, as regards its Applied Logic of the Sciences, (*e.g.* the Logic of Therapeutics, of Grammar *etc.*), is a standing testimony to the systematic completeness and rigour of the Hindu scientific mind. The difficulties of my task have been formidable, but I have not written one line which is not supported by the clearest and most authoritative texts. The ground trodden is, for the most part, absolutely new. I have gone back to the *origines*, and studied the authorities at first hand, being resolved to eschew all second-hand sources of information. Fortunately the Sanskrit philosophico scientific terminology,

however difficult from its technical character, is exceedingly precise, consistent and expressive. The materials also are full and the sources of information corroborate one another. Another difficulty I have sought to guard myself against is the unscientific, unhistorical but very common and almost inevitable habit of reading modern ideas into old guesses or speculations of a happy-go-lucky or nebulous character. I do not think that the mere passion for Truth is a sufficient safeguard against this fatal facility of unconscious distortion or misrepresentation. A true historical perspective can only be acquired by historico-comparative studies, with the application of the correct historico-comparative method (*vide* the Introduction to my Comparative Studies in Vaishnavism and Christianity). I have also practised, or tried to practise, a habitual understatement, without consciously falling into that '*suppressio veri*' which is so often a '*suggestio falsi*.' How far I have succeeded in exhibiting the truth about Hindu science or the Hindu scientific mind is a question which I leave to competent judges to answer.

Before concluding, I must advert to my use of the terms "isomeric" and "polymeric" in senses different from the current ones, though suggested by the principle of analogous extension. Instead of coining new terms, I adopted (perhaps with a questionable freedom) these existing ones to ex-

press the Hindu idea of distinctions of chemical substances due merely to difference in spatial position or arrangement among the particles, without any implications whatever as to percentage composition or molecular weight. A study of the original sources has made it clear to me that a "Bhúta" in Hindu Chemistry represents a class of elements composed of similar atoms, and the different elementary substances comprised under one and the same "Bhúta" are 'isomers', in this limited sense, in reference to the atoms, being specifically constituted by differences of spatial position and arrangement among the latter. This is true of the Sāṅkhya-Pātanjala and the Nyāya-Vaisesika alike. But in the Sāṅkhya-Pātanjala, the atoms themselves are composed of Tanmātras; and in one view, the atoms that enter into the "isomeric" modes of the same "Bhúta" are themselves "stereo-isomers" in reference to the Tanmātras. A tri-Tanmātric atom, for example may have different isomeric forms which would account for the divers modes of the "Bhúta" originating with this class of atoms. Hence under the Sāṅkhya Pātanjala, I speak of "isomeric" atoms, while under the Nyāya-Vaisesika I confine myself to the phrase "isomeric modes of the same Bhúta". It appears to me also that in the Sāṅkhya-Pātanjala view, while an atom of a particular kind (say a tri-Tanmātric or a tetra-Tanmātric one) may have "isomeric" forms of its own, the

atoms of the different "Bhúta" classes (from the mono-Tanmátric to the penta-Tanmátric) are what may in a broad sense be termed polymers of the A'kása Tanmátra and Bhútádi (matter-rudiment). Under the Sáñkhya-Pátanjala, therefore, I have spoken of "polymeric" atoms and "polymeric" combinations of these, though I must confess that I have done so with great diffidence and hesitation.

VICTORIA COLLEGE,
COOCH BEHAR.
23rd May, 1909.

B. N. SEAL.

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To the Memory of

M. P. E. BERTHELOT

I dedicate this volume of the History
of Hindu Chemistry.

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Introduction

CHAPTER I

On the age of Nagarjuna and the Buddhist Alchemical Tantras.

IN the first Volume it has been incidentally mentioned that side by side with the Sivaite Tantras we have their Buddhist counterparts in which the salient features of the former appear.* The question now arises : when did the votaries of the religion of Sákya-muni find themselves called upon to engraft upon their simple and pure creed the *ensemble* of the gross and grotesque superstitions, the hideous incantations, as also the speculative, the metaphysical and esoteric phases of spiritual aspirations of which the Tantras are the repositories ? The answer cannot be given off-hand

Rise, development
and propagation of
Maháyánism.

* Vol. i, Intro. lxx.

in a few words, for it will lead us to a discussion of the origin and development of Maháyánism. Under ordinary circumstances we should have considered it beside our purpose to devote much space to this subject in a work dealing with the history of chemistry. But it so happens that the most prominent figure in Indian alchemy, who is acknowledged on all hands to be the discoverer of the processes of distillation, sublimation etc., is no other than the reputed founder of the Mádhyamika system of philosophy, the renowned Nágárjuna. A brief and rapid survey of the causes which led to the origin of Maháyánism and its intimate connection with the tenets of the Sivaite cult will be of help to us.

It is one of the saddest episodes in the history of the great religions of the world that the purity of life, right conduct, right living—in short, the moral code upon which their founders have always laid particular stress, soon begin to occupy a subordinate position and a dogmatic theology springs up in time, which gives occupation to the subtlest intellect.

As for the masses of the people it is doubtful if ever they have remained contented with the mere ethical aspect of a religion. At any rate we find that immediately after the tidings of the death of Buddha had spread about there was a squabble among his followers for the possession of the master's corporeal relics and in course of time stúpas were raised over them, which no less than the three jewels (*Ratnatraya*)—the Buddha, the Dharma and the Samgha,—and the Bodhi-tree became objects of worship of the devotee. The Chaityas, Viháras and other sanctuaries of divers sorts, with which Buddhist India was dotted over in the first and second centuries after the decease of the great teacher, afforded asylums for a vast multitude of monks, who, freed from all worldly cares, found ample leisure to formulate and draw up a code of spritual and disciplinary exercises.

Although their high ideal was “to lead sweet lives of purest chastity” and induce their lay brethren to follow in their footsteps, rituals and ceremonials of an imposing and

elaborate character soon obscured the ray of light which shone forth from the founder. Thus we find that within 150 years after the passing away of Buddha tedious and circumstantial regulations as to the quality of robes to be worn by the Bhikshus, the mode of bathing and fasting, the taking of the midday meal, the drinking of unchurned milk, probation and penance, dwellings and furniture and so forth were amongst the weighty subjects for discussion in the Second General Council.* We need not pursue the subject further. The reader who is interested in the study of comparative religions will find striking parallels in the early history of the Christian Church.†

* "On the daily Life of the Bhikshus". *Vinaya Texts* (S. B. E. Series). The Chullavagga, Pt. iii, p. 66.

† The Sermon on the Mount was more or less forgotten. Idolatry disappeared, it is true, but only to re-appear in the shape of Mariolatry and the worship of Saints and relics. In the heat of the schismatic strife, Christian Charity had to make shift for itself as best as it could. Theologians were busy with the interpretation of the writings of the fathers. In a word, the dogmatic to a large extent superseded the moral element of religion.

We are not concerned here with tracing the rise, progress or decline of Buddhism ; if we have at all referred to its excrescences, it is only to prepare the mind of the reader for the proper understanding of the Maháyánist development.

The India of Asoka and of the fourth and third centuries B. C. was in the main Buddhist, but it should not for a moment be supposed that the old faith was extinct. The triumph and ascendancy of the teachings of Sákya-muni and his followers were due in a large measure to the fact that they drew upon, and incorporated into, their creed much that was essentially of Hindu origin.* As Dr. Bhándárkar observes :—

* Prof. Rhys Davids expresses the same views in several places :—“There is ample evidence even in the books of the orthodox body of Brahman teachers to show that when Buddhism arose there was not only much discussion of the ultimate problems of life, and a keen interest in the result but also that there was a quite unusually open field for all sorts of speculations”.—“Buddhism.” *American Lectures on the History of Religions* (1893), p. 26. Again: “But Buddhism is essentially an Indian system. The Buddha himself was,

"But it was not the metaphysical doctrines of Buddhism that influenced the masses of the people. What proved attractive was its ethical side. The Buddhist preachers discoursed on Dharma or righteousness to the people. Such discourses on Dharma without the introduction of any theistic idea have their representatives in the Brahmanic literature. In many of the episodes of the Mahábhárata especially in the *Sánti* and *Anusásanika* books we have

throughout his career, a characteristic Indian..... he was the greatest and wisest and best of Hindus."—*ibid.*, p. 117. The same high authority puts it more tersely when he says: "This is partly, no doubt, because we call them Buddhists, and imagine them, therefore, to belong to a separate class, quite distinct from other Indians of that stock. The Buddhists were, as a matter of fact, characteristically and distinctly Indian."—"Buddhist India," p. 165. Cf. "Buddhism, in fact, may be regarded as a reformed phase of Hindu religion and ethical activity. The Buddhistic doctrine of the vanity of the world had been thoroughly disseminated by Yájnavaalkya (in the *Satapatha Bráhmaṇa*) and with it the practice of subsistence upon alms as *Pravrájaka* or *Bhikshu*; and a fruitful soil had thereby been prepared for Buddhism". Weber's "Hist. Sans. Lit.," trans. 3rd Ed. (1892) p. 285. Again "This teaching contains, in itself, absolutely nothing new; on the contrary, it is essentially identical with the corresponding Brahminical doctrine; only the fashion in which Buddha proclaimed and disseminated it was something altogether novel and unwonted."—*ibid.*, p. 289.

simply ethical discourses without any reference to 'God, of the nature of those we find in the Buddhist-ic works'; and sometimes the verses in the Mahā-bhārata are the same as those occurring in the latter. There appears to be at one time a period in which the thoughts of the Hindus were directed to the delineation of the right conduct in itself without any theistic learning. And Buddhism on its ethical scale represents that phase. Right conduct is the last of the four noble truths of Buddhism."

* * * * *

"It was this phase of Buddhism that with the strenuous efforts of the missionaries and of the Emperor Asoka enables it to achieve success amongst the masses of the people; and what was wanting on the theistic side was supplied by the perfection and marvellous powers attributed to the founder of the religion. Without this faith in the perfection or, what we should call the divine nature of Buddha, a mere ethical religion would probably not have succeeded. Buddhism was not a social revolution as has been thought by some writers. It was a religion established and propagated by persons who had renounced the world and professed not to care for it. From times of old there existed in the Indian community such persons who were

called *Sramanas* and belonged originally to all castes. These gave themselves to contemplation and sometimes propounded doctrines of salvation not in harmony with the prevalent creed. Buddhism was not even a revolt against caste, for though men from all castes were admitted to the monastic order, and though in the discourses of Buddha himself and others the distinction of caste is pronounced to be entirely worthless, still the object of those who elaborated the system was not to level caste distinctions. They even left the domestic ceremonies of their followers to be performed according to the Vedic ritual. This is one of the arguments brought against Buddhism by Udayanāchārya. "There does not exist", he says, "a sect, the followers of which does not perform the Vedic rites beginning with Garbhādhāna and ending with the funeral, even though they regard them as having relative or tentative truth"* Buddhism, however, was a revolt against the sacrificial system and denied the authority of the Vedas as calculated to point out the path to salvation. And

*'नास्तेषु तद्दर्शनं' यत्र संहतमेतदित्युक्तापि गर्भाधानाद्यन्येष्टिपर्यन्तं । वेदिकीं क्रियां जनी नानुतिष्ठति । *Atmatattvaviveka*, Calc. Ed. of Samvat 1906, p. 19. संहत relating to संहति a Buddhist technical term.

this is the root of the hostility between itself and Brahmanism."*

The zealous missionaries of Buddhism captured the heart of the masses by appealing to their moral instincts. Persuasion and not persecution was the instrument they chose to wield. King Asoka proclaimed universal toleration ; he inculcated respect for Brahmins as well as *Sramanas* or ascetics of all sects. It is a relief to find that the mighty monarch had never recourse to brute force for the propagation of his creed. We are spared all the scenes of blood, rapine and violence, which disfigure the pages of religious history in the West.

It has already been pointed out that Buddhism itself may be looked upon as an offspring of Hinduism ; nay, it is a logical outcome of the principles enunciated in the

* "A peep into the Early History of India from the foundation of the Maurya Dynasty to the fall of the Imperial Gupta Dynasty" (B.C. 322—Circa 500 A. D.) pp. 362-363.

Journal of the Bombay branch of the Royal Asiatic Society (1900), Vol. xx. No. LVI.

Sámkhya system of philosophy. If India so readily responded to the teachings of the new faith, it is not because she renounced Hinduism but because she found that all that was highest and noblest in the latter was absorbed in the former. The great Teacher who now arose gave only a new shape and direction and a vigorous impetus to the germ of ideas already in existence and turned them to capital account. A good deal of confusion may be avoided by bearing in mind this aspect of the question. When speaking of Buddhist India one is apt to rush to the conclusion that every vestige of Hinduism had disappeared off the face of the vast continent. As a matter of fact even during the zenith of Buddhistic glory Brahminism was rearing its head and was professed by not a few among the cultured and intellectual classes and was ready to assert itself whenever a favourable occasion arose.

In the second century B. C., we find the Kábul valley, the Punjab and Málava ac-

knowledging the sway of the Princes of the Turkish race.* Wema Kadiphses, the second of the Kushana Dynasty is spoken of as a devotee of Mahesvara ; his coins bear the emblem of Nandin on the reverse, which is accompanied by a human figure which holds a trident in its right arm representing Siva. † The last three Kushanas—Kanishka, Huvishka and Vāsudeva—have been noticed in the *Rājataramgini*, ‡ and the emblems on the reverse of their coins are figures of deities borrowed from the Greek, Persian and Brahminical pantheon and of Buddha. Thus the Gods of all these four religions shared the adoration of these Turkish Kings. But the figure of Buddha in the

* Lassen "Indische Alterthumskunde," Vol. ii, pp. 811-13 Ed. 1874.

† *Ibid.*, pp. 808-811.

‡ See next page. Regarding the reliability of the account in the *Rājataramgini*, Dr. Stein observes :—"Kalhana's account of the reign of these kings, who are supposed to have ruled simultaneously, is brief enough, but undoubtedly preserves data of genuine historical tradition. It clearly describes them as princes of Turuska, i. e., Turkish nationality, as powerful sovereigns and as faithful patrons of the Buddhist Church. On these points the statements of

sitting or meditative and the standing posture is to be found on the coins of Kanishka alone.*

In the Buddhist ecclesiastical history Kanishka occupies a prominent place. It was in his reign and under his patronage that the Third Council was held to settle the canon once again. The church was convulsed by internal dissensions and schisms, resulting in its being split up into as many as 18 sects. "The most significant trait of the Third Council is that it closed a period of old quarrels between the sects ; it did not prevent the rise of new aspirations. Maháyánism, which in an incipient stage was already existing ere long, boldly raised its head."†

the Chronicle are fully supported by the evidence of our most authentic records. The continued existence of the three places, Kanishkapura, Hushkapura, and Jushkapura, which are described as foundations of these kings and which still survive to the present day is likely to have assisted in preserving a recollection of their founders."

* Percy Gardner : "Coins of Greek and Scythic kings" pp. 129 ff.

Cunningham : "Num. Chr." 1892, pp. 63 ff.

† Kern : Manual of Ind. Bud. (Grundriss d. Indo.-Arischen Phil.) p. 122.

Hinduism was now very much alive. After the Third Council the distinction between the Hínayánists and the Maháyánists became more and more accentuated. The apostles of the latter development became convinced that in order to draw into their folds the bulk of the people some sort of compromise was necessary, that orthodox Buddhism in all its rigidity must be given up. In other words, the neo-Buddhism which now sprang into existence began to absorb and assimilate the popular form of Brahminism and thus swell the ranks of its followers. A purely ethical creed has never secured a following except perhaps among a chosen few. To quote the eloquent words of the historian of "Rationalism in Europe" :—

"There arise from time to time men who bear to the moral condition of their age much the same relations as men of genius bear to its intellectual condition. They anticipate the moral standard of a later age, cast abroad conceptions of disinterested virtue, of philanthropy, or of self-denial that seem to bear no relation to the spirit of their time, inculcate duties and suggest motives of action that

appear to most men altogether chimerical. Yet the magnetism of their perfection tells powerfully upon their contemporaries. An enthusiasm is kindled, a group of adherents is formed, and many are emancipated from the moral condition of their age. Yet the full effects of such a movement are but transient. The first enthusiasm dies away, surrounding circumstances resume their ascendancy, the pure faith is materialised, encrusted with conceptions that are alien to its nature, dislocated, and distorted till its first features have almost disappeared. The moral teaching being unsuited to the time becomes inoperative until its appropriate civilisation has dawned, or at most it faintly and imperfectly filters through an accumulation of dogmas, and thus accelerates in some measure the arrival of the condition it requires." Vol. i, p. 305, Ed 1900.

The same historian in explaining the rapid spread of Christianity in Europe, observes in another place :—"It triumphed not so much by superseding rival faiths as by absorbing and transforming them. Old systems, old rites, old images were grafted into the new belief, retaining much of their ancient character, but assuming new names and a new complexion." A full and complete history of the

Among the bold spirits who took a leading part in this renovation the name of Nágárjuna stands conspicuous. The Mádhyamika system, with its axiom—*sarvam Sunyam*—a form of Pyrrhonism pushed to its extreme limits,

Nágárjuna : a leading representative of Maháyánism.

which is an essential part of Maháyánism, is generally ascribed to him. Northern Buddhist literature is replete with the marvels and miracles performed by him, and tradition has invested him with superhuman powers, Hiouen 'Thsang calls him along with Deva, Asvaghosha and Kumáralabdha, "as the four suns which illumine the world."* As early as A.D. 401-409 we find a life of Nágárjuna Bodhisattva translated into Chinese.† Táránátha has committed to writing all the floating mass of legends connected with this venerable name, but as the Tibetan monk wrote so late as the beginning of the 17th century A.D., and as nothing was too astounding for his pious credulity, we have here only

* Julien's texts, Vol. ii, p. 214.

† Bun. Nanjio's Catalogue, Ap. i, No. 3.

nuclei of facts round which have gathered accretions of vast proportions. It is now almost a hopeless task to separate the grain from the chaff. Nevertheless we can glean certain historical data from all that have been handed down. Before proceeding further we think it proper to treat the reader to a specimen of the materials with which one has to deal. We cull the following bits from the "Life and Legends of Nágárjuna" gathered chiefly from Tibetan records including Táránátha's "History of Buddhism."

"A rich Brahmin of the Vidarbha country to whom no son had been born for many years, once saw in a vision, that if he gave alms to, and entertained one hundred Brahmins, he could get a son. Accordingly he made offerings and prayers to the God and entertained one hundred Brahmins. After ten months his wife gave birth to a son. The rich man invited learned astrologers to predict the fortunes of his child ; but they found that it could not live more than a week. In all other respects the child was calculated to be fortunate..... The astrologers assured them (his parents) that if they entertained one hundred Bhikshus, it would

live seven years, beyond which its life could not be prolonged by any means whatever. When the seventh year was about to expire the parents were overwhelmed with grief. To avoid the painful sight of their son's predicted death, they caused him to be removed to a certain solitary place in company with a few retainers.

“As the boy (Nāgārjuna) was passing his mournful days, one day the Mahābodhisattva Avalokiteśvara Khasarpaṇa visited him in disguise and advised him to go to the great monastery of Nāleन्द्रa in Magadha as the surest means of escaping from the hands of death. He accordingly repaired to that famous Vihāra and arriving at the gate recited some gāthās. During that time the great sage Srī Saraha Bhadra was the high priest of Nāleन्द्रa, who ordained Nāgārjuna a Bhikshu of the Vihāra. * * * * During the latter part of his office the country was visited by a famine in consequence of which the monks fell into great distress. The Manager became very thoughtful about the terrible effects of the natural calamity. Distress and scarcity compelled the congregation more keenly to feel the necessity of money. The monks now determined to devise some means of acquiring treasures for the support.

of the famished congregation, and Nāgārjuna accordingly started on an expedition to visit an island in the great ocean where lived a great saint well versed in the art of alchemy. As the sea could not be crossed by any earthly means, he, by dint of his divine learning, got two leaves of an enchanted tree, by means of which he crossed the ocean and miraculously visited the island and presented himself before the sage who was greatly surprised to see a human being arrived at his abode deemed inaccessible to mortal beings. The sage earnestly inquired how he succeeded in achieving this wonder. Nāgārjuna replied respectfully stating to him the reasons of his visit and circumstances that brought him thither. He also showed him one of the enchanted leaves, concealing the other in his mendicant's platter. He begged him to teach him the art of turning metals into gold. The sage consented to the proposal, but not liking to let the wonderful art be known in Jambudvīpa, he determined to detain him for ever in the island by depriving him of the enchanted leaf. To effect this, he said that he could not teach the art of alchemy unless Nāgārjuna consented to part with the leaf. Nāgārjuna consented, and was taught the art. When it was fully mastered, he flew towards the Indian Continent by the help

of the remaining leaf. Returning to Nāleन्द्रa, by means of his easily acquired wealth he supported the whole body of monks. By his religious practices he obtained Siddhi (perfection). He refuted the theories of Saṃkarāchārya* and imparted religious instruction to the monks of Nāleन्द्रa.

“Nāgārjuna returned to his country after a visit to Uttarakuru and erected many chaityas and temples, composed many works on science, medicine, astronomy and alchemy. After the death of Saraha Bhadra, the office of high priest fell upon Nāgārjuna, which he managed with great ability and indefatigable zeal. He matured the Mādhyamika philosophy which was only conceived by his illustrious teacher Saraha.”

“Nāgārjuna is said to have been a great friend of king De-Chye (Saṃkara) of S. India, whom he converted to Buddhism.”

* An instance of glaring anachronism. Saṃkara flourished in the 8th.—9th century A. D. See below, foot-note to p. xxii.

† S. C. Dās : Journ. As. Soc. li, Pt. i, pp. 115—120.

One thing seems to be clear from the above, namely, that Nágárjuna was born and brought up in the Brahminical faith but was afterwards converted to Buddhism and was celebrated as an alchemist.

Táranátha, it is true, completed his History in 1608 A. D., * but he derived his materials from Tibetan sources and the analysis of Dulva by Csoma goes to confirm this account. We have already made use of the record left us by Hiouen 'Thsang. † It is thus clear that all the testimonies concur in ascertaining Nágárjuna not only as the originator of the Mádhyamika philosophy but also as an adept in magic, conjuration and alchemy, and that even so early as the 7th century A. D. The exact time during which he flourished is a matter of controversy. He is generally regarded as a contemporary of

Nágárjuna as an
adept in magic
and alchemy.

* Schiefner : *Gesch. d. Bud.* Pref. vi.

† *Vide* Vol. i, Intro. xciii.

Kanishka. One cannot go far wrong in assigning *circa* 150 A. D. as the date of his succeeding to the Patriarchate.*

* According to Lassen Nágárjuna lived about A. D. 23 during the reign of Kanishka. The Rájataramgini says: "Then there were in this land three kings called Hushka, Jushka and Kanishka, who built three towns named after them (Hushkapura, Jushkapura and Kanishkapura)..... During the powerful reign of these [kings] the land of Kásmír was to a great extent, in the possession of the Buddhas. At that time 150 years had passed in this terrestrial world since the blessed Sákya Simha (Buddha) had obtained complete beatitnde (Nirvána)..... And a Bodhi-sattva lived (then) in this country as the lord of the land, namely, the glorious Nágárjuna..... Stein's trans. Vol. I. pp. 30—31. As the tradition of the Northern Buddhists as recorded by Hiouen 'Thsang (Si-yu-ki, l. pp. 99, 151, the Tibetan Dulva (Csoma, As. Res. XX, pp. 92, 297) as also Schiefner (Tar, Gesch. d. Bud. p. 30!) concur in placing the commencement of Kanishka's rule 400 years after Buddha's Nirvána, the date assigned here to Nágárjuna is rather curious. Lassen sums up his conclusion on this knotty point in these words:—"Wegen der grossen Anzahl seiner Munzen mus dem Kanishka eine ziemlich lange Regierung Zugeschrieben werden ; ich glaube daher annehmen zu durfen, das er etwa bis 40 nach Chr. G. regiert habe." Fleet maintains B. C. 57. V. Smith c. 120 A. D. While Messrs. Bhándárkar c. 278 A. D. (Journ, Bombay Br. Roy. As. Soc. Vol. XX, No. lvi, pp. 269—365) as the date of Kanishka.

An important document has been preserved for us in its Tibetan and Chinese versions, which seems to have an historical basis. It is in the shape of a “Friendly Epistle of Nágárjuna to king Udyana.”*

Nágárjuna as a contemporary and friend of king Sadvahana.

The original in Sanskrit, entitled *Sukrillekha*, has not yet been recovered and probably

been lost. Udyana in the Tibetan subscription is Bdyé-Spyod = Sadváhana.† This Sadváhana is a prominent figure in the history of S. India. In ancient Sanskrit literature he is frequently spoken of as a patron of learning and there are several literary reminiscences associated with this name.‡

* *Vide* Wenzel : Journ, Pali Text Soc. (1886), p. 1.

† S. C. Dás (l. c.) says : “Nágárjuna is said to have been a great friend of king De-Chye (i. e. Samkara) of S. India whom he converted to Buddhism.” Now De-Chye = Bdyé-byed according to modern pronunciation. Dás is evidently in error in rendering De-Chye as Samkara (Wenzel).

‡ *Cf.*—Kāmasūtra of Vātsyāyana. कर्त्तव्यं कुलस्यः ज्ञातव्यैः ज्ञातव्यो मन्त्रादीर्न मन्त्रवर्तते [जज्ञान] । Referring to a “new” MS. of *Harshacharita* in his possession Hall remarks—“for Sālivāhana I there find Sātavāhana”—Intro. to “Vāsavadattā.” p. 54. This by implication would suggest that the other MS. had the reading Sālivāhana.

Now "the Andhrabhṛityas or Śātavāhanas ruled over the Deccan from B. C. 73 to about A. D. 218, i.e., for about 3 centuries.

"The period during which they ruled over Mahārāshṭra must have been a prosperous one in the history of the country. Hence several traditions with regard to different kings have been preserved.. But that Śālivāhana or Śātavāhana was a family name must have been forgotten and different princes of the dynasty have been confounded and identified. Thus Hemachandra in his Desikosha gives Śālivāhana, Śālana, Hāla and Kuntala as the names of one individual." *

The So-to-p'o-ho of the Chinese version of the "Friendly Epistle" has been identified with one of the Śātavāhanas or Andhra kings, possibly Yajna-Srī-Śātakarni. who seems to have reigned about 172—202 A. D. There is, therefore, nothing improbable in this particular, Śātavāhana being a contemporary of Nāgārjuna. In the alchemical Tantra, "Rasaratnākara," ascribed to Nāgārjuna,

* Bhāṣārkar's "Early History of the Deccan"—p. 36.

there is a true between this sage and Śālivāhana (p.). We shall revert to this subject later on.

Numerous works have been fathered on Nāgārjuna and it is an open question if any of them be genuine.* As is well known Vyāsa or more properly named Vedavyāsa has been taken to be the compiler of not only the four Vedas but also of all the Purāṇas put together. Piety and credulity go hand in hand and are seldom troubled with questions of anachronism. Plato, Democritus and Geber have been held responsible for writings which appeared several centuries later.

Nāgārjuna as a comprehensive name of the activity of Mahāyānaism.

Names, venerable and illustrious, have often been pressed into service to lend weight and dignity to productions which otherwise would not have commanded a respectful hearing. On the whole we are inclined to agree

* In Bunyin Nanjio's Catalogue of the Bud. Tripitaka there is a list of 24 works ascribed to Nāgārjuna. The *Suhśīlekha* was translated into Chinese in 484 A. D. App. pt. I, p. 368.

with Kern when he says, "The figure of Nāgārjuna, so prominent in the history of the rise of Mahāyānism, shows a double character. It is, on the one side, the name of an influential person, the first eminent leader of a school imbued with Hinduism and the methods of Indian scholastic philosophy. • On the other hand, Nāgārjuna is simply a comprehensive name of the activity of Mahāyānism in the first phase of its onward course."*

* In Vol. I of this work (Intro. xciii), we quoted Albérūnī as to the date of Nāgārjuna. This cultured Arab, ordinarily a very trustworthy guide, derived his information from the Brahmins of that part of India from which every vestige of Buddhism had disappeared in the 11th century and he was evidently misled on this point as the traditions relating to Nāgārjuna had at that distance of time become very vague. This will be clearly seen from what Prof. Sachau says in the preface to the Arabic edition of Albérūnī.

"Its civilization was then essentially Brahminical as it had come to be in a protracted struggle with Buddhism. Albérūnī does not know Indian Buddhism from personal experience though it had not yet entirely withdrawn from India and in some part was still a political power. (p. v.)

"The valley of the Kābul river and the Punjab are all that Albérūnī has seen of India. (p. xiii.)

"The high schools of Hindu science and learning, Kasmir and Benares, were in Albérūnī's time unapproachable for Muslems. (p. xiv.)"

From the time of Nágárjuna onwards Maháyanism began to be tinged more and more with Brahminical bias. A notable and decided step in this direction was taken by Asamga, a monk of Gándhára, who composed the Yogáchárabhúmisastra, in which by assimilating the doctrines of Patañjali he paved the way for the growth of Tantras. He seems to have lived about 400 A. D.* Vasubandhu, Asamga's younger brother, was another zea-

* Cf.—Takakasu : Journ. Roy. As. Soc. 1905.

A life of Vasubandhu was translated into Chinese by Paramârtha. A. D. 557-569.—Bun. Nunj. Cata. p. 371. Csoma Korosi following the Tibetan Chronology says :—"I know that Arya Asamga lived in the sixth or seventh century after Jesus Christ." As. Res. XX, p. 513. This date has been accepted by Lassen (*Ind. Alt.* ii, p. 460) as also by R. Davids (*Buddhism*. p. 267). But this chronology has now become untenable. The date of Asamga and his brother Vasubandhu should be put back by about two centuries, as some of their works were translated into Chinese in the beginning of the fifth century and perhaps earlier. (Bun. Nanj. Cata. App. i p. 371). It must have taken a century or two to have their works sufficiently recognised in India before they would deserve a place in the Chinese Tripitaka.

lous adherent of this school and is said to have been a teacher in the college attached to the monastery of Nálendra—the “Oxford of Indian Buddhism.” From Tibetan sources we learn that the celebrated logician Dig-nága was a disciple of Vasubandhu, a contemporary of Lha-tho-ri, king of Tibet, who lived up to 371 A. D.*

Maháyánism now began to adapt itself to its environments. The absorption of the Yoga ideas made the transition into the

Gradual and imperceptible fusion of Maháyánism with Saivism.

Tantric cult easy and Northern Buddhism began to develop and expand by entering into an alliance with Saivism, which favoured the growth of Buddhist Tantras. The origin and development of this class of literature have been the subject of a masterly exposition by Burnouf. The Maháyánists not only set up their own deities but borrowed copiously from the pantheon of the Hindus. Thus in the Sivaite Tantras while

* S. C. Vidyābhūṣaṇa : Journ. As. Soc., Vol i, (1905), p. 227.

the God Siva is the fountain of all knowledge and sciences, in their Buddhist counterparts we have the celestial, metaphysical and potential Buddhas* occupying the same position. The worship of the female energies (Sakti) which plays such an important part in the Tantras was encouraged in the person of Tárá. The Hindu Gods and Goddesses were also objects of adoration, only they were assigned a subordinate position. The question has often been asked : why did Buddhism seek alliance with Saivaism in preference to the Vishnuvite cult ? The answer seems to lie in the fact that it was precisely in those parts of India where the worship of Siva, especially in its Tántric form, had struck root that Maháyánism asserted its sway ; † and thus the apostles and propagators of the latter made most of the former. A few centuries later when Vaishnavism gained an ascendancy in Bengal the tables seem to have been turned. A gradual and imperceptible fusion

* i. e. the Bodhisattvas.

† Vide ante. p. xi, (under Wema kadiphas).

took place between the rival creeds. Thus in the celebrated adoration in the opening lines of *Gītagovinda* we find Buddha freely acknowledged as an incarnation of Vishnu and extolled for his abhorrence of sacrificial rites.*

From Fah-hian's travels we gather that in the beginning of the 5th century A. D., the Maháyánists were gaining the upper hand, though their rivals, the Hináyánists, were still holding their own in several localities. Thus at Mathurá and Pátaliputra he found the members of both the sects living side by side and having monasteries of their own.

* गिर्दास यन्मन्त्रिष्विरुद्धं श्रुतिजातम् सदयद्दयदर्शितपशुघातम् । ईश्वरं
हृतमुद्धवरीरं जय जगदीश्वरं ॥

It is scarcely correct to assert that Buddhism was exterminated in the land of its birth by cruel persecution. Cf. Vol. i. Intro. lxvii. The Bengali poet Ramchandra Kavibharati, author of *Bauddha Sataka*, though a devoted Buddha, belonged to the same class of thinkers as Jayadeva. Pandit S. P. Sāstrī is inclined to place him in the latter end of the 13th century.—Journal of Buddhist Text Society, Vol. I. Pt. iii. So late as 1441 A. D. MSS. of Buddhist works used to be copied from in Magadha.—Bendall's Camb. Cata. of Bud. Sans. MSS. (1883), pref. iv.

From the fact, however, that the pious Chinese pilgrim repeats the *Suramgama Sūtra* for his protection, we may conclude, since he is by no means a pronounced Maháyánist, that the predisposing causes for the origin of the Tantras were already in existence. "In this Sūtra is contained the most complete list of Dháranís (invocations) found in any Chinese compilation. There are 426 distinct sections containing the names of the different Buddhas and Hindu deities worshipped at the time of the composition of the Sūtra. Considering that Fah-hian in the early part of the 5th century regarded this book with reverence. We may reasonably assign it to a period not later than the end of the 1st century. Now amongst the invocations we find distinct reference to Dhyáni Buddha, Vairochana, Akshobhya, Amitábha and others shewing that they were coming to be recognised and worshipped even at that early date." *

* Intro. to Beal's "Fah-hian." (Lxxii).

These Dháranís may be looked upon as the precursors of the Tantras and they fully support the views that when they were composed Buddhism had turned a new leaf. The repeating of certain magic formulas along with the names of Buddha Amitábha, etc., was to secure salvation, in other words, “instead of the old doctrine [of *Karman*]—as a man soweth, so he shall reap—a new and easier way of salvation is here preached, viz. as a man prayeth, so he shall be saved. It is what is known to us as salvation by faith rather than by works. It would almost seem as if this popular and easy doctrine had secured to itself the name of Maháyána, as meaning the Broad Way, in opposition to the Narrow Way, the Hínayána.*

The new class of literature which now arose in order to meet the demands of the Maháyánist revival is collectively known as

* Max Müller, *Buddhist Mahâyána Sûtras*. Intro. to larger *Sukhâvati-Vyûha*, i x. S. B. E. Series, Vol. xlix.

the Vaipulya Sūtras or the Sūtras, of the developed school, of which Vaipulya Sūtras. the Dhāranis are an integral part. It found expression in such works as the "Saddharmapundarīka," "Lalitavistara," "Tathāgataguhyaka," "Prajñāpāramitā," etc., —all of which soon acquired almost canonical sanctity in the estimation of the N. Buddhists. Burnouf has tried hard to differentiate between the simple Sūtras as represented by the literature of the primitive orthodox Buddhism and the expanded Sūtras of which the distinguishing mark is the occurrence of Bodhisattvas.* This drawing of hard and fast

* 'La présence des Bodhisattvas ou leur absence intéresse donc le fonds même des livres où on la remarque, et il est bien évident que ce seul point trace une ligne de démarcation profonde entre les Sūtras ordinaires et les Sūtras développés. —Burnouf, Intro. p. 112; *ibid*, p. 120. Ed. 1844. *Vide* Max Muller's remarks at the end of the Smaller Sukhāvatī-Vyūha, p. 102, S. B. E. Series, Vol. xlix.

Cf. also "Some Vaipulyas are, materially, much like the old Sūtras, whole passages e. g. of Lalita-Vistara recur almost word for word in the Pāli Scriptures." Kern (Ind. Bud. p. 5). This eminent Buddhist scholar also very appositely re-

lines has been found to be well-nigh untenable.*

By the second century A. D. we find the leading beliefs and ideas as crystallised in the Maháyána literature fully in vogue. Thus we

marks elsewhere: "The results arrived at by Burnouf may be right so far as Mahávaipulya Sútra as a whole is concerned, they cannot be applied to all the component parts of such a work. Not to go further than the Saddh. and the L. Vistara, it can hardly be questioned that these works contain parts of very different dates, and from various sources."—Kern, Intro. to Saddh., pp. x-xi. Passages in L. V. are literally identical with those in Mahávagga. Again:—"These few examples I have chosen will suffice to prove that the material of a Mahávaipulya Sútra is partly as old as that of any other sacred book of the Buddhists."—*Ibid.*, xiv.

* The truth seems to be that "the historical relation between the Hínayána and the Maháyána schools of Buddhism is to me as great a puzzle as ever."—Max Muller, Intro. to L. Sukh. Vyúha, ix. Even the very distinction between the N. and the S. Buddhism has been taken strong exception to by R. Davids, who says:—"There is not now and never has been, any unity either of opinion or of language in what is called northern, or in what is called southern Buddhism. There is a distinct disadvantage in continually suggesting a unity which has no existence in fact. In a word the current division of Buddhist literature into northern and southern is entirely unscientific, and misleading."—Bud. India, p. 173.

come across in the "Buddhacharita" of Asvaghosha, who is admitted on all hands to be a contemporary of Kanishka, such a passage as this: "this, Sirs, is the Maháyána, the instrument of the law of the perfect Buddha, which is the establisher of the welfare of all beings, set forth by all the Buddhas."* The "Lotus of good Law" was translated into Chinese at the close of the second century A. D. †

Side by side with the growth of the scriptures another class of literature was called into being by the exigencies of the times—we mean the ^{Buddhistic Tan-} ^{tras.} Tantras, the necessity for which has been hinted at in the first volume. ‡ However esoteric may be the doctrines sought to be conveyed through the medium of these productions, it would be idle to deny that there

* Cowell's trans. p. 184. S. B. E. Series, Vol. xlix.

† Edkin's "Chinese Buddhism," p. 89. There were several versions of this sacred book.—*Vide* Kern's Intro. p. xxiii (S. B. E. Series).

‡ Vol. i. Intro. lxx.

is much in them which is calculated to pander to the baser instincts of frail humanity. At what particular time these Tantras appeared on the scene is yet a matter of conjecture, but the views of Wilson which held the ground for more than 30 years have now been found to be erroneous. Evidence is now forthcoming from quite an unexpected source, which goes to prove that Buddhist Tantras existed as early as the fifth or sixth century A. D., if not earlier. * If Buddhist Tantras, again, pre-suppose the existence of Hindu Tantras, one need not be considered as rash in assigning an earlier age to the latter.†

* *Vide* the palm-leaf MSS. discovered in the monastery of Horiuzi in Japan and carried from Central India. One of these is in the handwriting of a famous Chinese priest, named Kanshin, who came to Japan in A. D. 753. The MS. contains besides a Dhāraṇī, five Tantras. "Bud. Texts from Japan," ed. by Max Muller. Vol. i, pt. i, Intro. pp. 6-8. It is fair to conclude that these Tantras existed in the land of their birth at least two centuries earlier.

† Waddels says :—"No one has yet realised the vast extent to which Mahāyāna and Tántric Buddhist remains cover India ; nor sufficiently realised the leading part played by the Mahāyāna in Indian Buddhism during its popular period," *Journal of the Roy. As. Soc.* (1894).

The Tantras found a congenial home in China. Amoghavagra, a Sramana of northern India and a Brahmin by caste resided in the Celestial Empire for several years between 746 and 771 A. D., and under his influence the Tántric doctrines dealing with talismanic forms and professions of supernatural power first gained currency there.* Hence long before his time Tantras must have been popular in India. From the eighth to the eleventh century A. D. we are in possession of authentic records as regards the pre-

Tantras imported
into Tibet.

valence of Tantras in Northern India ; as it was about this period that several of these were gradually imported into Tibet by Indian Pandits, but they must have been composed much earlier. †

* Bun. Nanjio's Cata. App. ii, p. 445. Amoghavagra translated 77 works including Ushṛīsha-chakravarti-tantra, Garuḍagarbhaga-tantra and Vagrakumāra-tantra.

Cf.—Also "The existence of the Tantra Sāstras may thus apparently be traced at least as far back as the 6th century A. D."—*Vide* "Annual Report," As. Soc. Beng. 1906.

† In the first half of the eighth century two eminent

Atisa gave a fresh impetus to Tantrism in the land of snow. From the analysis of Mdo by Csoma we also come to know in detail the names with the dates of the Indian scholars who with the aid of the local interpreters (*lochavas*) rendered into Tibetan the various Sanskrit Tantras. The faithful accuracy with which these translations were made and their fidelity to the original enable us often to reproduce the Sanskrit Texts and thus we are in possession of valuable histori-

Pandits of Bengal visited Tibet at the invitation of its king and formally introduced there Buddhism; these Pandits were Sánti Rakshita; high priest of the monastery of Nálenda and his co-adjutor Padma Sambhava, a native of Udyana, who took charge of the Tántric part of the Buddhist liturgy. They were followed by the sage Dípamkara-Srí-jnána (Atisa), b. A. D. 980, d. 1053. He acquired proficiency in the three píṭakas of the four classes of the Hínayána Srávakas, in the Vaisesika philosophy, in the three píṭakas of the Maháyána doctrine, the metaphysics of the Mádhyamika and the Yogáchárya schools and the four classes of the Tantras. At the request of king Naya Pála he accepted the post of high priest of the monastery of Vikramasila.—*Vide* S. C. Dás,—Journal of the Buddhist Text Soc. Pt. i.

cal data.* Some of these Tantras deal with alchemy and their contents reveal to us the knowledge of chemical processes in India from about the 6th to the 8th century A. D.†

Fortunately we are not dependent upon the Tibetan Tantras alone for gaining an insight into this dark recess in the history of Hindu intellectual activity. In the course of our search

* Speaking of the Tibetan translation of Asvaghosha's *Buddha-Charita*, Cowell remarks: "The Tibetan version appears to be much closer to the original Sanskrit than the Chinese; in fact from its verbal accuracy we can often reproduce the exact words of the original, since Sanskrit words are always represented by the same Tibetan equivalents, as for instance the prepositions prefixed to verbal roots."—I. c. Intro. p. x. Waddel is equally impressed with the "profoundly accurate and scholarly nature of the Lāmaist translations of Sanskrit Buddhist books;" and he again observes: "It is clear that the Tāntric and Mahāyāna features of Lāmaism were imported *en bloc* from Indian Buddhism."—*Journal of the Royal As. Soc.* for 1894, p. 15.

† Analysis of the contents of the Mdo (Sūtra) by Csoma de Korosi—*Asiatic Researches*, XX (1836), p. 583. "A work on preparing quicksilver, the most powerful for subduing every sickness and for improving the vigor of the body."—"A work on turning base metals into gold." We are thus reminded of the contents of the *Rasārṇava* and the *Rasaratnākara*, *Vide* p. 2.

for MSS. of alchemical Tantras we have come upon a precious find, in the shape of a Buddhist Tantra, with Nágárjuna as its reputed author. Of alchemical Tantras we have had enough and to spare ; but there is great difficulty in assigning dates to them, as they one and all pretend to emanate from the mouth of the God *Siva* himself. We are only left to internal evidences—evidences based upon the gradual evolution of chemical processes, which we have not been slow to take advantage of. The MS. in question is a mere fragment, but it is calculated to

Its historical
importance.

 evoke all the zeal and enthusiasm of a Palæontologist—of an Owen or a Marsh—in his efforts to restore an animal and assign to it its proper place in the economy of the laws of evolution, when he luckily chances upon a fossil impression of its tooth or claws. From this point of view *Rasaratnākara*, for such is the name of our MS., is of uncommon interest. It is a Tantra of the Maháyānist school and as such its invocations are

addressed to all the Buddhas ;* and in one place there is a pointed reference to Prajñá-páramitá †(perfection of wisdom) appearing before Nágárjuna in a dream and revealing to him chemical knowledge.‡

A noteworthy feature of this work is that some chemical processes are discussed in the form of a dialogue between Sáliváhana and Nágárjuna, and Ratnaghosha and Mándavya.§ These last two names are held equally in veneration with Nágárjuna and grateful acknowledgments to their services occur in some later chemical treatises.¶ The bringing together of these four *dramatis personæ*.

* अविषयं सर्वभुक्ताम् । Cf. The opening invocation in the Sukhávati Vyúha : श्रीं नमः श्रीसर्वभुक्तीष्विदमन्त्रः । also नमः सर्वभुक्तां चार्चयामासाम् नमो विधिदत्तानाम् in A'rya Mañjuśrīmúla Tantra.—Vide As. Res. xx, p. 512.

† Cf.—The invocation in Vagrachchhediká नमो नमस्त्वा चार्चयामासाम् ।

‡ Vide Sans. Texts, p. 10, also Trans., p. 5.

§ Vide Sans. Texts, pp. 12-14, also Trans., pp. 6-8.

¶ Cf. Vol. i, p. 77.

especially of the first two has a significance of its own. We have already seen that references to Nágárjuna and his contemporary king Śáliváhana are only to be met with in ancient classical literature (*vide ante* xxii). It seems probable that Rasaratnákara was written at a time when the memory of these personages was still fragrant. Judging from internal evidences also we come to the conclusion that it is one of the earliest works extant on the subject. In our attempt at throwing light on the text of Rasárnava, we had to quote several parallel passages from it,* and from a careful perusal of both we are

Also a typical production of the Maháyánist period of intellectual activity.

of opinion that the latter is the inspirer rather than the borrower. Rasaratnákara, in short, seems to us to be a typical production representing the Maháyánist period of intellectual activity and we may not be wide of the mark if we put down 7th or 8th century A. D. as its latest date.

* *Vide* Vol. i, Sans. Texts, pp. 7, 12, 13 and 18.

From the 5th to the 11th century A. D. the colleges in connection with the monasteries of Pátaliputra, Nálándá, Vikramasila, Udand-pura, etc., were the great seats of learning as the temples attached to the pyramids in ancient Egypt ; and alchemy was included in the curricula of studies.*

The existence of a vast ancient Tántric literature with alchemy as a component part has now been placed beyond doubt, thanks to the searching examination of the Mahárájá's collection of valuable MSS. of Nepal by the eminent scholars Bendall, H. P. Sastri and S. Lévi. Of surpassing interest is the discovery of a Tantra belonging to the extinct school Kub-jikámata, written in Gupta character and copied about the sixth century A. D. This

* Cf. "By the side of the tower of king Asoka is built a Samghavása, belonging to the great vehicle, very imposing and elegant. There is also a temple belonging to the little vehicle.....In the college attached to the temple one may see eminent Sramanas from every quarter of the globe."—Beal's "Fah-hian," ed. 1869, p. 105.

school, though itself very ancient, presupposes the existence of other schools and we have distinct mention of the Maháyāna.* We now learn that the gradual fusion and amalgamation of Sivaite and Buddhist Tantras had begun even anterior to the sixth century. The Kubjiká-tantra was evidently composed outside India proper, probably in Nepal. The Goddess Párvatí encourages her consort to proceed to the continent for the spread of the tenets propounded by it.† In one place we come across a passage ‡ in which Siva himself speaks of párada (mercury) as his generative prin-

* Catalogue of Palm-leaf and selected paper MSS. belonging to the Durbar Library, Nepal, by H. P. Sastri (1905). lxxviii, *et. seq.*

दक्षिणे दीव्यानी तु पित्रयामस्तथोत्तरे ।

मच्छन्ने तु महायानं त्रिवसन्त्रा प्रजीयते ॥

† मच्छ त्वं भारते षडेक्षिकाराय सर्व्वतः ।

‡ महीर्य्यः पारदो यद्द पतितः स्फुटितं मणिः ॥

महीर्य्येण प्रदूतास्ते तावाय्यां सुनके वडि ।

तिष्ठन्ति संस्कृताः सन्तः भग्ना षड्विप्रजारणान् ॥

For the passages cited here we are indebted to the industry and courtesy of Pandit H. P. Sastri, who has wended his way through the bulky MS.

ciple and eulogises its efficacy when it has been killed six times.* We also find allusions to the transmutation of copper into gold with the aid of mercury. In short, we have ample references to alchemical processes described in the very technical terms in which *Rasārnava*, *Rasaratnākara* and other typical works of the Tántric period abound. †

It is now only necessary to wind up this chapter with an extract from the work of an eminent Buddhistologist with this reservation that the growing influence of Tantrism began as we have seen long before the 8th century.

"The decline of Buddhism in India from the 8th century downwards nearly coincides with the

* Even at the present day mercury, which has been *killed* six times in succession, each time with an equal weight of sulphur चङ्गुलचङ्गिमारित, is reputed to be one of the most potent of remedies.

† e.g. पक्षिण विद्धितो वेधः किं व्यञ्जती न विध्यते ।

रसविद्धं यथा तावत् न भूयसावतां व्रजेत् ॥

For the the meaning of the word वेध (Vedha) see this Vol. p. 18, *footnote*, also Vol. i, p. 120.

growing influence of Tantrism and sorcery, which stand to each other in the relation of theory to practice. The development of Tantrism is a feature that Buddhism and Hinduism in their later phases have in common. The object of Hindu Tantrism is the acquisition of wealth, mundane enjoyments, rewards for moral actions, deliverance, by worshipping Durgā, the *Sakti* of Siva—Prajñā in the terminology of the Mahāyāna—through means of spells, muttered prayers, Samādhi, offerings, etc. Similarly the Buddhist Tantras purpose to teach the adepts how by a supernatural way to acquire desired objects, either of a material nature, as the elixir of longevity, invulnerability, invisibility, alchemy ; or of a more spiritual character as the power of evoking a Buddha or a Bodhisattva to solve a doubt, or the power of achieving in this life the union with some divinity. There is an unmistakable affinity between Tantrism on one side, and the system of Yoga and Kammattāna on the other. Tantrism is, so to say, a popularised and, at the same time, degraded form of Yoga, because the objects are commonly of a coarser character, and the practices partly more childish partly more revolting.

“Tārānātha informs us that Tantrism existed and was transmitted in an occult manner in the period

between Asaṅga and Dharmakīrti, but that after Dharmakīrti's times the Anuttarayoga became more and more general and influential. Substantially his statement is certainly right. He adds that during the reign of the Pāla dynasty, there were many masters of magic, Mantra-Vajrācāryas, who, being possessed of various Siddhis, performed the most prodigious feats.

"The kings of the Pāla dynasty, whose sway over Gāṇḍa and the adjacent regions lasted from about A. D. 800 to 1050, are known both from the annals and their inscriptions as protectors of the Faith. It was during that period that the monastery of Vikramasīla was a renowned centre of Tantrist learning.

"The Sena kings, who followed the Pālas in the dominion over Eastern India, though belonging to a Hindu persuasion, were not hostile to the Faith. Still Buddhism declined during their reign and more so after the invasion of the country by the Muhammedans in A. D. 1200. The monasteries of Udandapura and Vikramasīla were destroyed; the monks were killed or fled to other countries. The learned Śākyasrī went to Orissa, and afterwards to Tibet; Ratnarakṣita to Nepāl; Budhamitra and others sought a refuge in S. India, whilst Saṅgama-Śrījñāna with several of his followers betook themselves to Burma, Camboja, etc.

And thus the Law of Buddha became extinct in Magadha.

"Many emigrants from Magadha rejoined their brethren in the South and founded colleges on a modest scale in Vijayanagara, Kalinga, and Konkan. The comparatively satisfactory condition of Buddhism in Dekkan about that time is attested by the rich donations to the monastery at Dambal."*

It will be noted that the monks of the monasteries of Udandapura and Vikramsila on their dispersion carried with them their learning and arts in the same manner of the Byzantine Greeks on their expulsion from Constantinople bore with them their intellectual treasures to the Italian cities. In the kingdom of the Deccan and in Tibet the Buddhist refugees found hospitable asylums, † just as the Greek Philosophers did in the Florentine Republic under the Medicii.

Spread of al-
chemy.

* Kern—Manual of Ind. Bud., pp. 133—134.

† Cf.—"The Deccan, which from the eleventh century was the refuge and centre of literary activity generally. In Hindustan it had been substantially arrested by the inroads and ravages of the Muhammadans,—Weber. Hist. Ind. lit. p. 283.

Some eminent orientalists, whose opinions naturally carry weight, have hitherto taken for granted that the knowledge of chemistry such as we find reflected in the Tantras quoted by Mádha in Rasesvaradarsana* was derived by intercourse with the Arabs.†

* Vol. i, Intro. lxxviii, *et seq.*

† *E.g.* Barth : "In regard to alchemy, anyhow in which the Sittars are zealous adepts, they were disciples of the Arabians, although other Sivaites had preceded them in the pursuit of the philosopher's stone. Already, in his exposition of the different doctrines of the Saivas, Sáyana thought he ought to dedicate a special chapter to the *Rasesvara-darsana* or "system of mercury," a strange amalgamation of Vedantism and alchemy. The object contemplated in this system is the transmutation of the body into an incorruptible substance by means of *rasapána*, i.e., the absorption into it of elixirs compounded principally of mercury and mica, that is to say, of the very essential qualities of Siva and Gauri, with whom the subject of the operation is thus at length identified. This species of transubstantiation constitutes the *jivanmukti*, or state of deliverance commencing with this present life, the sole and indispensable condition of salvation. It is clear that the devotional formulæ of the Vedánta are here only a sort of jargon, under which there lies hid a radically impious doctrine ; and it is not less clear that in this doctrine, which had from the fourteenth century produced a rather considerable literature, there is an infusion of Mohammedan ideas. The Arabs of the Khalifat had arrived on these shores in the character of travellers or merchants, and had established commercial relations and intercourse with these parts long before the Afghans, Turks, or Mongols, their coreligionists, came as conquerors."—"Religions of India," ed. 1891, pp. 210-211.

The attentive reader who has followed us all along could not have failed to notice that it was in the Universities of Nálendá, Ulandapura and Vikramasíla, in Central India and Magadha, precisely the regions which were cut off from communication with the external world, that Tantric mysticism with alchemy as an integral part was cultivated and from thence spread to Bhot (Tibet) and the regions lying to the south-east of it,* and South India.†

* See under colophons to *Rasahrídaya* and *Rasasátra* respectively.

† The last rallying point of Hindu learning and sciences was the kingdom of Vijayanagara, which was in the heyday of its glory under Bukka I (A. D. 1354-1371) with Mádhava as his prime Minister. Wilson says :—"The history of Vijayanagara is a subject of considerable interest in the annals of India, as the last barrier that was opposed to Muhammedan invasions, and that preserved the southern part of the Peninsula from foreign rule until a very modern period."—*As. Res.*, Vol. xx (1830), p. 1. See also Sewell's "A Forgotten Empire"—(Vijayanagara).

CHAPTER II.

Having thus far prepared the ground for believing that alchemy along with other cognate branches of learning was the outcome of Indian intellectual activity, we shall now proceed to follow it up with its further development. At the outset it is, Further cultivation of alchemy. however, necessary to remember that on the decline of Buddhism the vigorous impetus which its followers gave to literature and science was not lost to India. Nay, during and after the revival of Brahminism under the Gupta dynasty and its successions we have some mighty intellectual giants whose productions will continue to shed lustre as long as the Hindu nation exists. Kálidása and Bhavabhúti, Brahma Gupta and Āryabhatta, Samkara and Rámánuja are names which may be regarded as the heritage not of India alone but of the entire civilized world. At the time of the Brahminic revival Buddhist works of acknowledged merit far from

being cast aside were held in veneration. Amarasimha in his Lexicon and Vāgbhata in his *Ashtāṅgahrīdaya* *, as also the pseudo-Vāgbhata * commence with an invocation to Buddha, which has never shocked the tolerant spirit of the Hindu. Charaka and Susruta also bear distinct impress of Buddhist retouching. The Buddhist Tantras became likewise a part and parcel of Hindu religious-philosophical literature,† the subject-matter

Buddhist alchemical Tantras absorbed into Hindu Tantras.

of the former was incorporated into the latter, the names of Tārā, Prajñāpāramitā and Buddha being simply changed into those of Pārvatī and Siva. In *Rasaratnākara* itself we have distinct indications that it is an admixture of both.

* Vol. i, p. 76.

† Speaking of a typical Buddhist production belonging to this category Burnouf observes: "Ce morceau est exclusivement spéculatif, et il nous offre une nouvelle preuve de l'alliance intime que le système des Tantras a contractée avec la philosophie buddhique la plus élevée" (l. c. p. 543 ed. 1844).

It should thus be understood that the works under review in this chapter are based upon their Buddhist counterparts ; in short, there is no disposition to ignore the debt of obligation the authors are under to Nágá-rjuna, Ratnaghosha, Mándavya and others.

In the introduction to the first volume we stated : "It is to be regretted that the several works quoted by Mádhaba [on the science of mercury] Rasárnava alone seems to have survived to our days" (l. c. lxxxiii). Since then we have been fortunate enough to procure as many as three transcripts of MSS. of Rasahridaya by Govindabhagavat from different quarters. As Mádhaba speaks of this author in terms of the deepest reverence and regards him as "ancient,"*we think we should not err on the wrong side if we place the author some three

* Cf. Vol. i, Intro. lxxx.

तत्प्रपञ्चस्तु नीतिमन्त्रवत्यादाचार्यैर्दत्तैश्चरामेवरमहारक्षप्रचक्षिभिः
प्राचीकैराचार्यैर्निर्दयितः ।

The qualifying epithet मन्त्रवत् is only applied to venerable-
Rishis of old.

centuries before his time. If our surmise be correct, he should have lived about eleventh century A. D. The only personal allusion which the author has condescended to offer for the edification of posterity is that he wrote his book at the request of the king of the Kirátaland, *i.e.*, the region adjoining modern Bhotan. Portions of this remarkable treatise after a careful collation of the MSS. have been reproduced in the proper place. The worn-eaten fragmentary MS. produced from Benares is 386 years old. Internal evidence equally goes to establish the antiquity of this work. The author was evidently a Buddhist as we learn from the colophon to the Benares MS. (*vide* trans. p. 12). It is, however, not to be found either in the India office or the Nepal MS. This important omission is easily accounted for. It is the reluctance of the latter day Hindus to acknowledge their obligations to a Buddhist author.

Rasārṇava which has been noticed at length in the first volume and to which was assigned the 12th century A. D., as also Rasaratna-

samuchchaya (13th to 14th century), need not further arrest our attention.

The presentation of the various treatises of the Tantric and iatro-chemical periods under discussion in their exact chronological sequence is not an easy task ; in the absence of more definite information, we are afraid, we shall now and then have to hazard a conjecture.

The introductory lines of Books viii and ix of Rasaratnasmuchchaya, in which Somadeva is mentioned as the author of the descriptive part, led us to suspect that they are merely reproductions from "a standard work on the subject by Somadeva, no longer extant."* Our surmise has proved to be partially correct. We have at last been able to recover the supposed lost work. A transcript of a MS. of Rasendrachúdámāni by Somadeva, preserved in the Library of the Deccan College, Poona, reveals to us the fact that

* Vol. i, p. 118.

practically all the important portions of this book have been woven into the text of *Rasaratnasamuchchaya* ; and this gives us an additional opportunity of collating many doubtful passages in both. But the present work itself does not lay claim to originality. It makes a candid admission that it culls all its materials from pre-existing chemical treatises.* It further puts forward the alchemist Nandi as the inventor of the process of sublimation and of the *Koshthi* apparatus (Vol. i, pp. 69 and 89).† *Nágárjuna*, *Dandí*, *Sambhu* and the sage *Brahmajyoti* are also spoken of as sources of his inspiration. We get very little inkling into the personal history of *Somadeva*, except that he was the ruler of a city named *Karaválabhairava*. The fact that *R. R. S.* lays *Rasendrachudámani* so amply under contribution would suggest that the latter had become somewhat rare

- * अथ यन्माषि वक्ष्यन्ते रसतन्त्राख्यनेकशः ।
समाखीक्य समासेन सोमदेवेन साम्प्रतम् ॥
- † ऊर्ध्वपातनयन्त्रं हि नन्दिना परिकीर्तितम् ।
कोष्ठिकायनमेतद्धि नन्दिना परिकीर्तितम् ॥

or that its contents had been well-nigh forgotten when the former was compiled. Its date may therefore be put down between the 12th and 13th centuries A. D.

Another important work of this period is *Rasaprakāśa-sudhākara* by Yasodhara. The author of R. R. S. in the opening lines mentions the names of 27 alchemists to whom he is beholden, among which occurs that of Yasodhana. We have little doubt that the

Rasaprakāśa-sudhākara. correct reading is Yasodhara.

We now find that there is very little original matter in R. R. S., it being made up of citations from *Rasārṇava* and the works of Somadeva and Yasodhara. We should not, however, be understood to retract the high encomiums we thought fit to bestow upon R. R. S. for "its methodical and scientific arrangements of the subject-matter, which would do credit to any modern work."* Its author has never laid claims to originality, but, on the contrary, has freely acknowledged the sources he drew upon. The student of

Hindu chemistry, however, like a weary but devout pilgrim, must wind his way through intricate and thorny paths and feel ineffable joy at being able to approach the original fountain undefiled. It now transpires that the credit for the accurate observations on the metallurgy of zinc (Vol. i., pp. 88 & 156) really belongs to Yasodhara. While the author of B. R. S. always scrupulously admits that his work is a mere compilation, Yasodhara, on the other hand, is anxious to let the world know that the processes he describes have been verified by experiments performed with his own hands.* Among the authorities he cites are Nágárjuna, Devísástra (probably Rasárñava), Nandi, Somadeva, Svachchhandabhairava and Manthanabhairava. As Yasodhara quotes Somadeva, he must have been posterior to the latter by at least a hundred

* *Of.* स्वहस्तेन कृतं सम्यक् कारणं न युतं मया ।

स्वहस्तेन भवभीमेन कृतं सम्यक् युतेन हि ॥

पातुबन्धुसूतरीयीऽसौ स्वहस्तेन कृतो मया ।

हृष्टमन्त्रवशीनीऽयं कथितो नात्र संशयः ॥

years and he should therefore be placed in the 13th century A. D. *

Rasakalpa likewise seems to belong to this period. It is in the shape of a Tantra, but curiously enough it is not much troubled with consistency. In the opening salutation Siva, "the king of mercurial lore" and his consort Chaudikā are reverentially bowed to—a procedure scarcely reconcilable with the position of a revealed document. The colophon at the end of each Chapter (उक्ताम) claims the work to be a part and parcel of Rudrayāmala Tantra; at the same time due acknowledgment is made to the contributions of Govinda, the author of Rasahridaya, Svachchhandabhairava and other adepts.† Towards the end the author says : "The processes described have all been verified by me and not borrowed at second-hand from my teachers." Needless to add here that the God Siva would not have

* We are using a copy of the MS. preserved in the Runbīr Library, Kāsmīr. The readings are on the whole accurate.

† E. g. सर्वोपायैर्बद्धीरिताः ।

been at pains in justifying the necessity of his production with such a timorous apology. From internal evidence it is abundantly clear that it could not have been composed earlier than the 13th century A.D.

As the author has confined himself solely to a description of the metals, minerals and the processes of "killing" them with the agency of various apparatus and has not gone into the treatment of diseases with the aid of mineral preparations, he has been able to condense much important information within the narrow compass of a few short chapters.

Rasarājalakshmi also deserves some prominence here not because of its intrinsic worth but because of the references to previous Tantras and alchemists, amongst which are Rasār-nava, Kákachandīsvara, Nágárjuna, Vyádi, Svachchhanda, Dámodara, Vásudeva and Bhagabat Govinda. We have also categorical mention of the purely Ayurvedic works such

as Charaka, Susruta, Háríta and Vágbhata, to which our author is equally indebted.* From the colophon to the MS. procured from Benares we learn that the author Vishnudeva was Court Physician to king Bukka.† If this statement be accepted—and *prima facie* there is no reason to question it—this treatise must have been compiled in the latter part of the 14th century. Internal evidence equally supports this date.

* *Vide* Sanskrit Texts, pp. 80-81.

† *Vide ante.*, footnote, xlix.

CHAPTER III.

C. 1350 A. D.

We now proceed to examine the contents of another series of works belonging also to the Iatro-Chemical period ; the one characteristic feature of which is that opium is recognised as an official drug in the *materia medica* portion. These may be taken to date from the middle of the 14th century A. D.

Rasanakshatramálikā by Mathanasimha, physician to the king of Malwa, should find a place in this chapter. For particulars as to the contents the reader may consult p. 22. The date given by the copyist of the MS. is *Samvat* 1557 i.e. 1500 A. D. The work itself is therefore older.

Rasaratnākara by Siddha Nityanātha, son of Párvatí, comes under this category.* The author gives the sources of his information and explains the object of his compila-

* Two editions of this somewhat voluminous work have been published—one by Ganesa Chandra Ghose (Calcutta),

tion in the following words : “Whatever has been revealed by Siva in Rasárnava under the preparations of mercury ; the Dípiká of Rasamangala on mercury ; all that has been said by Nágárjuna for the benefit of people afflicted with diseases, as also by Siddha Charpati, by Vágbhata and Su-sruta,—all these and many other treatises on mercury and minerals being consulted, I have, after rejecting the drugs and medicaments which have become rare and difficult to procure, put together [in my work] the essential features thereof. * * * * All that I have learned from my teachers and have been in a position to subject to practical tests has been incorporated into my work for the benefit of mankind.” In addition to the authorities cited above Nityanátha quotes from Chakrapáni and Rasendrachúlamani (*ante* liv).

the other at the “Venkatesvara Press” (Bombay). We have compared the readings of these two editions with the MS. in the Library of the Sanskrit College, Calcutta. They agree fairly well.

Rasendrachintāmaṇi will next claim our attention. We have before us the printed copy, edited by Umesa Chandra Sena Gupta, late librarian, Sanskrit College, Calcutta, in which the text has been adopted, as the editor informs us in the preface, after collation of 3 or 4 MSS. We have carefully gone over this edition and compared its readings with those of a MS. procured from Benares and another from the Runbīr Library, Kásmír. All these agree in the main, but there happen to be certain omissions and additions, which form an interesting chapter in the history of interpolations in the literature of this description. To begin with : there is a dispute over its very authorship. Some MSS. ascribe it to *Dhundhukanátha*, disciple of *Kálanátha*, others to *Rámachandra*. After the customary salutation there occur two couplets in the Calcutta edition, which are not met with in the Benares and Kásmír exemplars. In these the author is made to justify his *raison d'être* for undertaking his task in these words :

Rasendrachintā-
maṇi.

“I shall give publicity only to such processes as I have been able to verify by my own experiments.” Such protestations have already been noticed more than once.* In another place we have : “Those mercurial operations alone have found a place in my book, which I have been able to put to tests. Those who teach without being able to perform experiments labour in vain.” This last couplet is quite out of place as it hangs like a tail to a long extract from Rasárnava and is in fact conspicuous by its absence in the Benares and Kásmír MSS.† For the second time we find calomel designated as Rasakarpúra (lit. camphor of mercury ; *vide* vol. i, p. 250). This preparation no doubt occurs in the older

* Such pretensions put forth on behalf of the author, especially in the first person singular, lead one to suspect that they are later interpolations. In the Arabian alchemy Geber is often made to declare to the same effect : *e.g.* “J’ai expérimenté moi-même tout ce que je rapporte.”—Berthelot, “La Chimie au moyen A’ge,” t. 1, p. 338. The well known egoistic couplet in Susruta, Ch. i, चङ् ह्रि चञ्चलरिरादिदिवः is generally regarded as an interpolation.

† The extract commences with त्वं माया सर्वव्यापिनी.

works, *e. g.* *Rasárnava* ; but it is described there as the white “ash” of mercury (*sveta-bhasma*). The recipe for calomel as given in the Calcutta edition, however, is quite different from that in the Benares and Kásmír MSS. and it is altogether wanting in one of the MSS. in the Calcutta Sanskrit College Library. We are therefore not without suspicion that it has been foisted into the original composition. The author refers to *Rasárnava*, *Nágárjuna*, *Govinda*, *Nityanátha*, *Siddha Lakshmívara*, *Trivikramabhatta* and *Chakrapáni*. There is a lengthy colophon but no direct information can be derived from it as to the age of the author.

Rasasára : It is a comprehensive but purely chemical work dealing with 18 operations on mercury ; various chemical processes are incidentally described, a good many of which, however, overlap each other. There does not seem to be any justification for coining a multiplicity of technical jargons to connote each of these. But prolixity was never regarded in the light of a vice by the

alchemical writers of the middle ages either in India or in Europe. The contents of *Rasasāra* often remind us of a poem on alchemy by George Ripley, canon of Bridlington in Yorkshire (b. about 1460), of which Rodwell says :—

“But we cannot point to a new fact which he elucidated. He divided all chemical operations into twelve processes—calcination, dissolution, separation, conjunction, putrefaction, congelation, cibation, sublimation, fermentation, exaltation, multiplication and projection. Several MS. copies of his poem exist in the British Museum, bound up with copies of the works of Roger Bacon and earlier writers. Here is a specimen of his rugged rhymes :—

The first chapter shall be of natural *Calcination*;
The second of *Dyssolution*, secret and phylo-
sophycall ;

The third of our elementall *Separation* ;

The fourth of *Conjunction* matrimoniall ;

The fyfth of *Putrefaction* then followe shall :

Of *Congelation* *Albyficative* shall be the Sixt,

Then of *Oybation*, the seventh shall follow
next.”*

* *Vide* “Birth of Chemistry”.

The author, Govindáchárya, as a devout Hindu, begins with his adoration of Siva and Vishnu and tells us at the outset that his treatise is a compilation and epitome based upon standard works on the subject and the contributions of the adepts. We have every reason to be thankful to him for the many hints he throws on the sources of his information. Of surpassing interest is his declaration that for a knowledge of certain processes he is indebted to the Buddhists of Tibet.* This must be taken to mean that the cultivation of alchemy had become neglected and almost forgotten in India proper and the earnest searchers for this lore had to repair during the time of our author to Tibet. Confirmatory evidence to this effect is equally

* एवं बौद्ध विज्ञाननि माटदीर्घनिवासिनः ।

Towards the close of his work the author again acknowledges his obligation to the Buddhists.

बौद्धमतं तथा ज्ञात्वा रससारः कृतो मया ।

We have in our possession five transcripts of the MSS. of *Rasasāra* procured from the Libraries of Káśmír, Tanjore, Ulwar, Madrás and the Temple of the Goddess Kálí, at Ramnâ, near Dacca, Bengal.

furnished in the colophon to *Rasahridaya* (trans. p. 12). During the decadence of Buddhism and the corresponding ascendancy of Brahminism in Bengal, say about the 11th to 13th centuries A.D., this branch of science also found a safe retreat in the land of the Kirátas as we have already seen. Burnell, under the influence of his preconceived notion, namely that Indian alchemy owed its origin to the Arabs, very naively remarks : “By *Bauddhas* he (the author) probably means the Muhammedans (*of* the vernacular Malayálam use of the word), though studies of this nature were much pursued by the later Buddhists.”*

Some idea of the date of *Rasasára* may be formed from the fact that there is mention of opium in it. But our author was evidently quite in the dark as to its origin ; for, says he : “There are 4 different kinds of poisonous

* Catalogue of the Tanjore Palace MSS. pt. 1, p. 70. Burnell draws his conclusions from the reference to Buddhists in the colophon ; but we have quoted above another passage in which distinct mention is made of the Buddhists of Tibet.

sea-fish, and it is from their foam that 4 different kinds of opium are derived, namely, white, red, black and yellow ; while others maintain that it is derived from the foam of the snake and it is very properly used for chemical operation,"* *e. g.*,—killing and fixation of mercury. From the context it is, however, doubtful if the narcotic drug is really alluded to here. But independently of the use of this term we may safely place this work in the 13th century A. D.

* समुद्र चैव जायन्ते विषमत्स्नाद्यतुर्विधाः ।

तेभ्यः फेनं समुत्पन्नम् अहिफेनो विषं स चतुर्विधं ।

क्षेत्रिहदन्ति सर्पाणां फेनं स्यादहिफेनकं ।

यथा—वारचं श्वेतवर्णं च रक्तवर्णं च आरकं ।

सारचं पीतवर्णं च कृष्णवर्णं च मारकं ।

विषविदुस्तमं फेनं युज्यते रसकार्येण ।

The Sanskrit word for opium, "ahiphena," lit., foam of the snake, is of modern date. It is generally held that this word has been Sanskritised from the Arabic "aphiyūn."

These identical distichs also occur in the commentary on Sārṅgadharā by A'dḥamallā with the additional line, वाक्त्रः (खाद्यजः) क्षीरनिक्षेपः, namely, it is the milky juice of poppy ; proving that during the time of the latter its real origin was known, at the same time its supposed origin was not disbelieved.

Sárngadhara-samgraha—a compilation by **Sárngadhara** : its peculiarity is that it is based upon the A'yurvedas (Charaka, etc.) on the one hand and the Tantric chemical treatises on the other. In the chapter on the purification and incineration of metals, 7 of these are recognised, but strange to say there does not occur any mention of zinc. Later on, 9 metals are named including two alloys, brass and bell-metal, after the 9 planets, the significance of which will be discussed in the proper place.

The date of **Sárngadhara** can be ascertained with accuracy, as besides this medical compendium he is the author of the **Pad-dhati**, a voluminous miscellaney, containing, with other matters, a poetical anthology. The author dates his work in *samvat* 1420 or A. D. 1363. The name of the author's father is **Dámodara** and that of the grandfather **Rághavadeva**. The latter was highly considered by **Rájá Hammíra**, the Chauhan.*

* After the sack of Chitor by Alla-ud-din in A. D. 1303, Mewar was occupied by the garrisons of Delhi. Hammíra

There is a big commentary on this work by A'dhamalla, whose ancestors settled in the city founded by Hammíra.*

Rasendrasárasaṁgraha : The author, Gopálakrishna, begins by admitting that his treatise is a mere compilation based upon many Tantras, though he mentions by name only two, namely, Rasamañjarí and Chandriká. Special stress is laid on the therapeu-

recovered his ancestral throne and during his prosperous rule of sixty-four years (1301-1365) and that of his successors arts and literature found liberal patrons (*vide* Tod's "Annals of Rájastan"). The court of Hammíra attracted another distinguished physician named Saugata Sinha as we gather from the colophon to a noted recipé,

एषा सौगतसिंहनाकभिवला लोके प्रकाशीकृता

इन्द्रोपाय महीभुजे * संजीवभाजी मृगम् ।

* A'dhamalla gives an account of his family. His Grandfather was one Chakrapáni, not to be confounded with the celebrated medical author of Bengal (Vol. i, Intro. liv) and he himself was attached to the court of a ruler named, Jaitrasinha, whose capital Hástíkántapurí was situated on the river Charmanvatí. We reproduce in the next page the text which is somewhat corrupt from the copy preserved in the Library of the Sanskrit College, Benares.

tic efficacy of mineral preparations.* Like Rasendrachintámāni it assigns a minor place to the ancient Ayurvedic method of treatment by kasháyayoga, i. e., by herbs and simples ; as far as the knowledge of chemical processes goes, it must be held inferior to the former. Numerous medicinal recipés

श्रीवासव्यकुलप्रकाशमन्त्रयो ये पूर्वजा विभुताः

श्रीहृन्नीरपुरे * * * *

तदन्वये किं बहुना प्रसिद्धश्रीचक्रपाणिः कुलक्षेत्रवेद्युः(न्दुः)

* * * * *

तस्य बुद्धिसुमगस्य तन्मूर्त्ति भावसिंह इति भूपतिमान्धः ।

* * * * *

तस्यात्मजो दीर्घमति प्रहृष्टो नाकादमहो * *

तेन * * बीणाश्रिते (?) (विनाश्रिते) शार्ङ्गचरप्रकाशः ।

हासीकान्तपुरी पुरा पुरणिता काशीव विद्वज्जने-

र्याता यत्र सरःसरिद्वयवरा चरन्त्यसौ पापहा ।

यस्यां हृदयवासुदेवचरचन्द्रान्धुजः आपतिः

स्यासौ धर्मप्रवाहि धर्ममतिषु श्रीकैवसिंहः प्रभुः ॥

तस्यां शार्ङ्गचरीकानां बीणानां च प्रकाशिनी ।

क्षिप्रते सादमन्त्रेण संज्ञितायाः प्रदीपिका ॥

* For a description of some of these vide "Journal des Savants," April, 1898.

agree word for word with those in Rasendra-chintámani, which only proves that both have drawn on a common stock. There is no question of the one borrowing from the other, as internal evidence proves that both belong to the same period. Abhayánanda Gupta in the preface to his edition says :—"There is a tradition to the effect that Gopála Kavibhúshana of Dakshina Vāṅga is the compiler of this book ; but this can scarcely be accepted as he lived not long ago." Again. "Its commentator, Rámasena Kavindramani (author of Arthabodhiká) was court physician to Nawáb Jaffer Ali Khan of Bengal (Mir Jaffer) some 200 years ago." Rámasena himself quotes from 3 commentaries of this book ; hence it was recognised as of some degree of importance at that time and must have been composed long before. This work is very popular in Bengal and is a *vade mecum* of the local Kavirájas.

Rasendrakalpadruma is another work of this period. It deals chiefly with mineral preparations and is a mere compilation from

Rasárnava, Rasamaṅgala, Ratnākara, Rasāmṛita and Rasaratnasamuchchaya ; the numerous citations with which it is replete are of some use in correcting many doubtful readings in these latter. Our MS. is incomplete, the first few couplets and the sequel being lost ; for the opening lines of the work see Aufrecht's Catalogue of the Bodleian Library, MSS., pt. 1, p. 321.

Dhāturatnamālā : This epitome is devoted exclusively to short processes of *killing* metals and minerals. Six metals are recognised at the outset, namely, gold, silver, copper, lead, tin and iron as in the ancient works; but strange to say later on *kharpara*,* which is the mineral calamine, is taken as synonymous with *jasada* or zinc. We have before us a MS. procured from Benares. It is full of corrupt readings. The copy noticed in the Bodleian Library Catalogue seems to be more correct. From the colophon in the latter we learn that the author is one Devadatta of Gujarāta, but in the Benares exemplar

* Vol. i. p. 158.

this portion has been coolly tampered with, so that this poor compilation may be palmed off as an integral part of a *Samhitá* of the *Asviníkumáras*, the divine physicians, and thus entitled to the respect due to revelation. This work cannot be placed earlier than in the 14th century. Here we have a serious sidelight into the history of literary forgeries.

CHAPTER IV.

MODERN PERIOD.

1500—1600 A. D.

We have now arrived at what may be termed the modern period in Hindu chemistry and materia medica. The characteristic of this period is that over and above opium, we have some other foreign drugs incorporated into the materia medica. By the beginning of the 16th century A. D. the Portuguese had fairly established themselves at Goa and some other parts of India,* and as a result of intercourse with them, that dreadful scourge—the venereal disease—had made its appearance. Sanskrit medical treatises from the Charaka and Susruta downwards and ending with Śārṅgadharma are silent about this malady though they give fairly

* The political influence of the Portuguese as early as 1533 A. D. is evident from the fact that Sultan Bahadur, king of Gujarāta, entered into a treaty with them and through their assistance raised a force of 6,000 Abyssinians—"Memoirs of Humayun".

accurate descriptions of diseases of the genital organs (उपदंश). But syphilis had now to be reckoned with and a new name had to be coined for it. Accordingly we find *Rasa-pradīpa*, one of the standard works of this period given to Tantric method of treatment, prescribing calomel and *chobchini* (China root, *Smilax China*, Linn) for what is now termed for the first time *Phirangaroga* or the disease of the Portuguese. According to Flückiger and Hanbury "the use of this drug as a remedy for syphilis was made known to the Portuguese at Goa by Chinese traders about A. D. 1535." Thus from an independent source we can arrive at the approximate date of *Ras pradīpa*. This work also gives us a detailed process for the preparation of mineral acids by distillation which is here termed *samkhadrávaka* (lit. a solvent for conch shells) and is described as "endowed with the property of dissolving metals." It is thus evident that the use of mineral acids as a solvent for metals was unknown in India before this time.* A very

* *Vide* Note on mineral acids, vol. i. p. 185.

noteworthy circumstance in connection with this is that the Bhāvaprakāśa, which is posterior to Rasapradīpa, is silent about sam-khadrávaka, which had come to be prescribed by this time as a favorite remedy for indigestion and derangement of liver and spleen; the solvents being borax, treacle, etc.—(cf. vol. i, p. 130). In the Bhāvaprakāśa among the acids we have only the juices of acid fruits. This is only another instance of the danger one is liable to incur by drawing inferences from *argumentum ex silentio*.

Rasakaumudī is another compilation belonging to this period and as far as its contents go it is comparable to Rasapradīpa in many respects; both opium and mineral acids are prescribed. From the colophon in the Calcutta Sanskrit College Library MS. we gather that the author is a physician named Mádha-va. Curiously enough he is often confounded with the celebrated Mádha-vakara, the author of the Nidánasamgraha, who preceded the former by some 8 or 9 hundred years.

The next work which should now claim our attention is the well known Bhāvaprakāśa of Bhāvamisra. It is a voluminous compilation in which the Ayurvedic method of treatment has been mainly adopted and as such ample citations are given from the Charaka, Susruta, Vñgbhata, Háríta, Vrinda and Chakrapáni. But the Tantric remedies could not altogether be given a wide berth and accordingly one or two chapters have been devoted to mineral preparations ; but these have been borrowed chiefly from Rasapradípa, Rasendrachintámáni, Sárñgadhara and other standard works. Bhāvamisra has been scrupulously candid in his acknowledgments to the various authorities quoted by him. *Phirangaroga* is mentioned as also its treatment with the help of calomel and *chobchini*. The author lived about the time of the Emperor Akbar and evidently in that part of India which is now known as the United Provinces and it is not to be wondered at that Mussulman influence is discernible in his book.

We conclude our survey of this period.

with the notice of a remarkable production entitled *Dhátukriyá* or “operations with metals”; it is in the shape of a dialogue between *Siva* and *párvatí*; in short, it pretends to be a part and parcel of the *Rudrayámala Tantra*.* The work cannot be placed earlier than in the 16th century A.D., as it contains reference to the country of the *Phirangas* and to *Rúma*, the Arabic name for Constantinople. For the first time we come across the very appropriate term *dáhajala* (lit. burning water) coined to denote sulphuric acid. The information about the metals is of very meagre and poor description and it has been needlessly spun into an inordinate length. The author evidently considers it a pious fraud to make such statements as follow emanate from the mouth of *Siva* himself :—

“By using coins made of imitation gold one can carry on exchange . . . and thus enrich oneself.”

* We have in hand transcripts of two MSS.—one from the Library of the *Mahárájá* of Ulwar, the other named somewhat differently, *Dhátumañjarí*, from Benares. They agree very closely.

The curious reader who is referred to the translations of the selected portions of the text given elsewhere will not fail to recollect similar passages in the Leydén Parchment where the dishonest goldsmith gives numerous recipes for "augmenting gold." * Fraudulent attempts in the direction of palming off alloys of base metals, possessing bright, yellow lustre, for gold, have been made in all ages and in all climes (*cf.* extracts from *Rasárnava*, Vol. i, p. 74).

Arkaprakāsa or a treatise on the preparation of medicinal tinctures and essences should also find a place here; † its authorship is ascribed to Ravana, the mythical king of Ceylon. The contents of the work, however, reveal its date. For instance, mercury, treated with S'amkhadrāvaka, is prescribed as the remedy for "Phiraṅgaroga" (syphilis).

* Berthelot : "Collection des Alchimistes grecs" (trad. p. 287). "La Chimie au Moyen Âge," T. i. p. 31.

† There is a Calcutta edition published by Ganēsa Chandra Ghosha; we have compared it with a MS. procured from the Sanskrit College, Benares. They agree remarkably well.

Opium also is prescribed ; while the term *yasada* is used to indicate zinc. As a distilling apparatus a tinned copper vessel is recommended. Mahommedan influence is distinctly discernible in this hybrid production. The very title of the book is no doubt Sanskritised from the Persian *arrak* (essence).

It is unnecessary to proceed further. We have before us the MSS. of *Rasamañjari* by *Sálinátha*, of *Rasarañjana*, of *Gandhaka-kalpa* (a Tantra), of *Rasárñava* (quite distinct from the standard work bearing the same title), of *Rasaratnákara* (altogether different from that of *Nityanátha*) and several others. As all of these repeat *ad nauseam* the processes already described, we refrain from examining their contents here.

CHAPTER V.

INDIGENOUS ORIGIN OF INDIAN ALCHEMY.

The reader who has been able to follow us throughout with patience will not have been slow to recognise that alchemy in India has been developed all along on independent lines. Its origin and growth are interwoven with a phase of religious activity—the outcome of purely indigenous traits—which has been discussed at length in chapter i.

The only instance in which we find some allusion to adepts outside the pale of Hindu institutions occurs in *Rasaratnasamuchchaya*.* But the term *Mlechchha* used there is a generic one applied indiscriminately to

* *श्रेष्ठकसाधनम्*. *Vide* Vol. i, Sans. texts, p. 56 ; a variant in the Poona edition has *नेष्टकसाधनम्*, which must be rejected as both the Benares and Kásmír MSS. accept the former.

the Sakas, the Yavanas (Greeks or Bactrians), the Chinas (Chinese), etc. The Hindus have never been shy of acknowledging their obligations to the Yavanas; Varáhamihira for instance expresses his admiration for the proficiency of the latter in the field of astronomy and would gladly learn at their feet.* In the Mahábhárata again we find the services of the Yavana architect, Purochana, requisitioned. We have not, however, come across a single passage, which may be construed into implying a hint to alchemists in the West. That the term Mlechchha in R.R.S. really refers to the Kirátas is evident from the colophon to Rasahridaya. †

Those scholars who have hitherto maintained that Indian alchemy is of exotic origin, have, we are afraid, done so on *a priori*

कौण्डिन्दि यवनासुषु सस्यक् शास्त्रमिदं स्तितम् ।
 ऋषिब्रह्मसुषु पुण्यन्ते किं पुनर्देवविद्वजः ॥

† Sans. texts, p. 39; there the four castes (चतुर्वर्ण) are distinctly mentioned and the kirátas evidently included under the Mlechchhas.

hitá, if anything, is a repertory of astrological notions. In vain do we look even there for any such chance and solitary reference.* The alchemical literature of India is equally silent about it. † True it is there are two metals which are often designated as the sun and the moon respectively, namely copper

* Chapter xvi of this work treats of "countries, people and things belonging to the domain of each planet." Among sundry other things "the Sun is the lord of gold and fire." Thousand and one articles are said to be presided over by the Moon, Mars, Mercury, Jupiter, Saturn, Venus, Ráhu and Ketu ; but nowhere is there any connection between the planets and the metals. *Vide* Kern's trans., pp. 97—101.

† The mythical origin of some metals is given in the Puráṇas ; but no reference to the astral bodies is to be found. Thus silver originated from the tears of the God Siva, copper from the semen of the God Kártikeya, lead from the semen of the Snake God Vāsuki, iron from the different parts of the body of the demons called Lomilas ; and gold from the semen of the God of fire. Some vague and remote connection only can be established between this sort of nomenclature and that of the old Greco-Egyptian alchemists. According to the latter mercury is sometimes designated as the semen of Hermes ; whilst in the Tantras it is the semen of Siva (हराजीव). *Vide* "Intro. a l'étude de la chimie des anciens," p. 11.

and silver.* But this has nothing to do with the planetary generation of these metals. In the imagery of the Sanskrit poet the crimson tint of the rising sun and the pale white lustre of the moon are comparable to the colour of copper and silver respectively.

The old Greek writers repeatedly refer to the mystic relationship between the seven planets and the seven metals. In the Sanskrit literature, however, beginning with the Susruta and coming onwards to Rasaratna-samuchchaya, we invariably find six metals recognised, alloys being rigorously excluded from the list and regarded simply as “artificially made.” † It is only in the Sārṅga-dhara and other later works that we find seven metals enumerated ; ‡ but this author

* रवि, चरु and other synonyms are as a rule applied to copper but rarely to gold.

† *Vide* Vol. i, pp. 48, 72 and 127.

‡ (चार) brass being taken as the additional metal ; zinc was evidently unknown to Sārṅga-dhara.

सूर्यतारारतायाश्च ज्ञानवद्भौ च लीलाकम् ।

चातवः सप्त विज्ञेयाः ।

is guilty of a curious inconsistency, since in a subsequent part of his book he adds two more to the list and quietly lays down that there are nine metals, *which derive their names from the nine planets*.^{*} This may be read as a sort of vague and indistinct connection between the metals and the astral bodies.

The Arabs who adepted many of the Greek doctrines of alchemy also represented the seven metals by the seven planets. In fact it was through the medium of the Arabs

^{*} "Kámsya" (bell-metal) and "Vrittaloḥa" or "Vartaloḥa" (cf.—Vol. i. p. 114) make up the number. Ráhu and Ketu are the two mythical planets; they are in reality the ascending and descending nodes in the ecliptic. Ráhu is supposed to cause the eclipse of the sun and the moon by swallowing it up.

Sáringadhara stops here, but his prolix commentator, A'dhamaḥalla supplies the deficiency by making copper stand for the Sun, silver for the Moon, brass for the Mars, iron for Saturn, gold for Jupiter, tin for Venus, lead for Mercury and bell-metal and vartaloḥa for Ráhu and Ketu respectively.

It will also be noticed that lead is here represented by Mercury; but in the Hindu alchemy mercury always stands as the visible manifestation of the God Śiva, it being generated from his semen, hence the name *वर्षीज* given to it.

and the Jews that a knowledge of the Greek sciences including alchemy filtered to the European nations during the middle ages.* We have already seen that Rájputána had been overrun and even occupied for a brief period by the Mussulman conquerors shortly before the time of Sárngadhara and it is reasonable to suppose that he had gleaned some astrological notions from that quarter.

We now advert for a moment to the main question of the connection of the comparatively modern and scientific phase of Hindu astronomy with the science of Alexandria. Although it is admitted by all those who are entitled to speak with authority on the subject that the Hindus borrowed from the Greeks and thus improved upon their older system, many points have yet to be cleared up. Professor Whitney who has

* "C'est par l'intermédiaire des écrits arabes et hébreux que la plupart des connaissances scientifiques des Grecs en mathématiques, en astronomie, en physique et en médecine, ont été transmises au moyen âge occidental; les écrits Grecs proprement dits n'ayant guère été connus directement avant la Renaissance."—"La chimie au Moyen Âge," T. i. p. 229.

carefully studied the subject is struck with the circumstance that the Sūryya and other Siddhāntas bear resemblance to the system of Hipparchus rather than that in the Syntaxis.* In other words the transmittance of astronomical knowledge must have taken place before the time of Ptolemy. Now the period of lively intercourse is precisely that covered by the age of Ptolemy and that of his followers, and yet the Indian astronomers seem to be unaware of his teachings.†

* Intro. to "Sūryyasiddhānta". We find from Ptolemy that the observations of Hipparchus extended from B. C. 162 to B. C. 127. Ptolemy flourished at Alexandria in the second century A. D. under the reigns of Adrian and Marcus Aurelius.

This was also pointed out long ago by Colebrooke, *e. g.* "The whole cluster of astronomers mentioned by Brahma Gupta must be placed in the interval between the age of Hipparchus, and possibly that of Ptolemy."—*Essays*, pp. 411—412.

† A'ryabhatta composed his treatise "Laghvāryabhattīyam," in 496 A. D., and Varāhamihira his "Pañchasiddhāntikā" about 550 A. D. But these astronomers borrowed from the much older treatise entitled "Romakasiddhānta" ascribed to Śrīseṇa, and Paulīśasiddhānta (*vide* Thibaut Intro. to Pañchasiddhāntikā, xxvii—xxvi).

This mystery has never been elucidated ; Dr. Thibaut's arguments are ingenious, but, we are afraid, by no means convincing.* Indeed in the purely mathematical sciences the Hindus far excelled the Greeks of the Alexandrian school. A'ryabhatta's knowledge of algebra was superior to that of Diophantus and as for arithmetic it is generally acknowledged to be of Indian origin.†

The last word on the subject has yet to be said and it is doubtful if this dark recess will ever be illumined. In the meantime it would be better to hold our judgment in abeyance. At best we can only launch into hypotheses

* L. c., pp. li and liii.

† Cf.—Colebrooke : "Admitting the Hindu and Alexandrian authors to be nearly equally ancient, it must be conceded in favour of the Indian algebraist, that he was more advanced in the same."—*Essays*, ii, 429. Again, "in the whole science he [Diophantus] is very far behind the Hindu writers," *ibid.*, p. 438.

Kaye has recently questioned the priority of the claims of the Hindus : *Vide* J. A. S. B. iii [N. S.], July, 1907.

or indulge in dogmatic assertions.*

* One who approaches this subject should divest himself of prepossessions or the "bias of patriotism" as Herbert Spencer puts it. A very agreeable feature in this controversy is that those who are most competent to speak with authority are extremely modest, nay diffident in giving expression to their views. Woepcke in his masterly memoir "on the propagation of the Indian numeral symbols" says :—"La solution parfaite de ces problèmes ne résulterait que d'une connaissance tellement complète des événements et de leurs phases, qu'il faut à peu près renoncer à jamais l'obtenir. D'un autre côté, remplir les vides par des hypothèses arbitraires au preconçues serait livrer l'histoire des sciences aux hasards et au dogmatisme des inspirations individuelles." "Journal Asiatique" (1863).

Lassen whose modesty is only equalled by his profound scholarship observes :—"Es wäre sehr wünschenswerth, dafs ein mit der gehörigen Kenntnifs der Sanskritsprache ausgerüsteter Kenner der Mathematik und Astronomie es unternähme, aus diesen vorhandenen Hilfsmitteln die Lücken unserer Kenntnifs auf diesem Gebiet des Indischen Alterthums auszufüllen ; für jetzt müssen wir uns darauf beschränken, die hauptsächlichsten Ergebnisse der bisherigen Untersuchungen zusammenzustellen." "Indische Alterthumskunde." Vol. ii. p. 1150 ; ed. 1874.

CHAPTER VI.

SOME NOTED INDIAN ALCHEMISTS AND THEIR WORKS.

Aufrecht in his notice of the MS. of *Rasaratnasamuchchaya*,* evidently from a mistaken notion that the pursuit of chemistry was unknown in ancient India, goes somewhat out of his way in asserting that the names of the 27 alchemists, mentioned in the beginning of that work,† are mostly apocryphal. We have, however, positive proofs that these personages far from being evolved out of the imagination of the author existed in real flesh and blood and contributed not a little to the progress of chemical science. Thus we read in *Rasaratnākara* of “chemical operations performed by *Māṇḍavya*” and also find *Ratnaghosha* taking part in a dialogue on certain processes, ‡ *Yasodhara*, again, is the author of the comprehensive work named *Rasaprakāśasudhākara*

* *Catalogus Catalogorum*. ii. p. 116.

† *Vide* Vol. i, p. 77.

‡ Eng. trans. pp. 6—8

which we have noticed at some length in the present volume. 'Vyádi is a prominent name both as a grammarian as well as a chemist. The 'Garudapurána quotes him as an authority on gems.* 'Nandí, as we have already seen, is distinctly referred to by Somadeva as the inventor of the *koshtí* apparatus and of the process of sublimation. †

There are, indeed, a great many names scattered throughout the mass of chemical and medical literature, some of which have been handed down to posterity, sometimes on account of the important processes they invented and sometimes, again, because of the efficacy of the metallic preparations which they introduced. Thus in *Rasendra-chintámāni* we come across the name of Siddha Lakshmívara. The names of the sage 'Brahmajyoti, 'Manthánabhairava, 'Svachchhandahhairava and 'Gahanánandanátha have in this manner been rescued from oblivion. Most of these were Buddhist monks.

* आदिर्जगत् जगतां हि महाप्रभावः सिद्धी विदग्धचित्ततत्त्वज्ञा ददातुः ।

† Intro., lv.

"Sivadāsa in his commentary on Chakrapāṇi quotes besides Patañjali, Bhavyadattadeva as an expert on iron preparations. We give below the names of some of the authors and their works over and above those already noticed. It is scarcely possible to submit an exhaustive list.

Name of the Author.	Name of the work.
Ānandānubhava	Rasadīpikā.
Balabhadra	(Unknown).
Bhojadeva	Rasarājamrigāṇika.
Chandrasena	Rasachandrodaya
Charpata	Charpatasiddhānta.
Dhanapati	Divyarasendrasāra.
Garuḍadattasiddha	Rasaratnāvalī.
Gorakshanātha	Gorakshasamhitā.
(Unknown)	Bauddhasarvasva.
(Unknown)	Rasesvarasiddhānta.
Harihara	Rasavisvadarpana.
Kaṅkāli	Rasakaṅkāli
Kapāli	Rasarājamahodadhi.
Kesavadeva	Yogarātnākara.
Mallāri	Rasakautuka.
Narahari	Rasayogamuktāvalī.
Rāmarāja	Rasaratnapradīpa.
(Siddha) Bhāskara	Rasendrabbhāskara.
(Siddha) Prānanātha	Rasadīpa.
Śrīnātha	Rasaratna.
Trimallabhatta	Rasadarpana.
Vaidyārāja	Rasakashāyavaidyaka.
Vandimīra	Yogasudhānidhi.
Vāsudeva	Rasasarvesvara.

The Tantric Period

(Continued).

Chemistry in Rasaratnākara of Nāgarjuna.

[In the rendering of Rasaratnākara of Nāgārjuna and other Sanskrit texts we have often given only free translations. Such passages as are unnecessary repetitions or are not of sufficient interest to the general student of the history of Chemistry have been left out.]

CHAPTER 1.

I shall now speak of the purification of the important rasas* (minerals).

What wonder is it that rājāvarta digested with the juice of *Acacia sirisa* converts silver of the weight of one guñja into one hundred times its weight of gold of the lustre of the rising sun ? 1

* Regarding rasas see Vol. 1, p. 79.

What wonder is it that yellow sulphur, purified with the juice of *Butea frondosa*, converts silver into gold when roasted thrice over the fire of cowdung cakes ? 2

What wonder is it that calamine.....roasted thrice with copper converts the latter into gold ?* 3

* These laconic recipes all refer to the floating mass of traditions current at the time of the author on the transmutation of the base metals into gold. As they are of a fragmentary and disjointed character, the meaning is not always clear. Recipe 3 also occurs in *Risârnavâ*; *vide* Vol. i, pp. 70-71. Various ingenious methods were resorted to for debasing gold or making an alloy, which would mimic the appearance of this metal. Silver, copper, lead, zinc and mercury were often made into an amalgam, and the latter rendered compact and coloured yellow with the aid of orpiment. No wonder that the law-books prescribe several penalties on the fraudulent debasers of the precious metals. Thus according to Manu "the king shall cause a goldsmith, who behaves dishonestly, the most noxious of all the thorns, to be cut to pieces with razors." IX, 292.

The reader who feels interest in this subject may consult Berthelot's "*La Chimie au moyen âge*," t. 1. pp. 31 *et seq.*, where will be found several recipes for augmenting gold *aurum plurimum facere*, or for the "fabrication of gold." One example may be cited here. "Take gold, copper and mercury, make an amalgam of the whole, afterwards add sulphur, orpiment, "sandarac" (a kind of resin) and the bile of the vulture &c." The author of the recipe thus concludes :—"Thou wilt now discover a secret, which is sacred and worthy of praise" (l. c. p. 35).

What wonder is it that cinnabar digested several times with the milk of the ewe and the acids* imparts to silver the lustre of gold glowing as saffron ? † 4

Digestion [of minerals] is to be effected in the decoction of *Dolichos uniflorus*, *Paspalum scrobiculatum*, the urine of man and the acid juices of [the fruit of] ratan (*Calamus rotang*) and afterwards with the addition of the alkalies (soda, borax &c.) The operation of roasting is to be performed thrice.—Cf. the process of Rasaratnasamuchchaya (R. R. S.), Bk. ii, 67-68 in Vol. i, p. 83.

What wonder is it that the pyrites macerated in the juice of *Musa sapientum* and in castor oil and clarified butter, and placed inside the bulb of *Arum campanulatum* and roasted [in a closed crucible] undergoes perfect purification ? † 6

Chapala and other minerals, being macerated in the juice of the lemon for 3 days, become purified. Gold being smeared with the 5 earths, the ashes and salts ‡ and roasted, undergoes purification. 12.

* Vegetable acids are meant here. *Vide* Vol. i, p. 128.

† Here extraction of copper from the pyrites is no doubt meant. Cf. R. R. S. Bk. ii, 89-90 ; *vide* Vol. i, p. 84.

‡ Cf. R. R. S. Bk. x, 71, 85 ; *vide* Vol. i, pp. 128-129.

Silver alloyed with lead and fused with ashes becomes purified.* 13

Lo ! it is not to be wondered at that copper, melted with the alkali derived from the earth† and the milk of the ewe, clarified butter and one-sixteenth of its weight of oil, will become pure like the crescent of the moon. 14.

Verses 23-25 : Extraction of the essence of vaikrānta : exactly the same as in R. R. S. Bk. ii, 71-72. *Vide* Vol. i, pp. 83-84.

Verses 25-30 : Have reference to the extraction of copper from mākshika and tāpya (varieties of the pyrites). They agree in all essentials with Rasārnava, Ch. VII, 12-13. *Vide* Vol. i. p. 70

Verses 31-32 : Extraction of zinc from calamine. Cf. R. R. S. Bk. ii, 163-164. *Vide* Vol. i, p. 88.

Verses 35-36 : Exactly the same as in R. R. S. Bk. ii, 103-104. *Vide* Vol. i. p. 85.

Verse 37 : Essence of darada, *i. e.* extraction of mercury from cinnabar by distillation. Cf. R. R. S. Bk. i, 89-90. *Vide* Vol. i, p. 78.

* Refers to cupellation. Cf. Rasārnava in Vol. i, p. 68, footnote (1).

† इक्षीकृमिना वादेन may refer to natron or to saltpetre.

Verses 50-51 : Dissolution of gems (pearls &c.) by digestion in vegetable acids, *e. g.* sour gruel (impure vinegar) and the juice of certain acid plants.

* * * *

Here ends Chapter Second of *Rasaratnākara* by Nāgārjuna on the *killing* of diamond and the metals, extraction of the essence of minerals and liquefaction of mica.

CHAPTER III.

I shall now explain [the process of] fixation of mercury. The king of rasas (mercury), rubbed with the juice of lime, sal-ammoniac, the acids, the alkalies, the 5 salts, *Piper nigrum*, *P. longum*, the dried root of ginger, the juice of *Moringa pter.*, the tuber of *Amorphophallus campanulatus*, can readily amalgamate itself with the 8 metals. 1

Prajñāpāramitā (perfection of wisdom) appeared before Nāgārjuna at midnight in a dream and revealed to him the ingredients of a recipe (consisting of steel, copper, mica, pyrites, &c.) 4

Mercury is to be rubbed with its equal weight of gold and then [the amalgam] further admixed with

~~~~~

sulphur, borax &c. The mixture is then to be transferred to a crucible and its lid put on and then submitted to gentle roasting. By partaking of this elixir (*i e.* the sublimate) the devotee acquires a body not liable to decay. 30-32

I shall now describe the Garbha yantram.\*  
62-65

Recipe for Kajjali or æthiops mineral.† 84-86

\*                      \*                      \*

~~~~~

Having made salutation to all the Buddhas, free from the taint of sins, I shall now deliver the Kakshaputa tantram ‡ for the benefit of suffering humanity.

[The most important part, from an historical point of view, is the dialogue between Nāgārjuna, King Sālivāhana and Ratnaghosha.]

Nāgārjuna, whose end (salvation) had been attained, benevolent towards all living creatures, blessed with all favours, residing on mount Śrīsaila, before him stood Ratnaghosha with folded arms,

* The same as in Rasārṇava. *Vide* Vol. i, p. 66.

† The process is practically the same as in Chakrapāni; *vide* Vol. i, p. 58.

‡ There is extant a Tantra, which goes by this name, the reputed author of which is Nāgārjuna.

saying : "Be pleased to communicate to me knowledge on chemical operations."

Nāgārjuna said :—

Well done ! well done ! I am pleased with your devotion and shall convey to you all that you want to know, namely remedies for warding off wrinkles, grey hair and other signs of old age. Mineral preparations act with equal efficacy on the metals as on the body (human system). *

* * * *

For the benefit of living beings I went through all manner of penances for 12 tedious years and worshipped the goddess Yakshinī presiding over the *Ficus religiosa*. Then I heard an oracle.

Nāgārjuna said :—

O Goddess ! if thou art propitiated, be pleased to communicate to me the rare knowledge of the fixation of mercury.

* * * *

Sālivāhana said :—

I have dedicated to thee, O Goddess ! treasures of gold and gems, now I await thy instructions.

* This was a favourite metaphor with the alchemists. Cf. Vol. i, Intro. lxxvi.

The Goddess said :—

Well done ! well done ! O wise ruler ! I shall speak to you of chemical operations performed by Māṇḍavya.* ... A disciple should be intelligent, devoted to work, sinless, and master of his passions. †

The apparatus known as *koshtāhi*, mouth blow-pipe, cow-dung, substantial wood (as fuel), a pair of bellows, iron plates, * * * having collected all these, chemical operations are to be performed. ‡

* * * *

Ratnaghosha said :—

Having prepared with great care “the powder of projection,” which transforms a ten million times its weight of the base metal into gold, § * * *

Nāgārjuna said :—

I shall convey to you what has been experimented upon by Sākāṇḍa. ¶

* A well-known alchemist ; one of the 27 adepts mentioned in the opening lines of R. R. S. *Vide* Vol. i, p. 77.

† Cf. “Initiation into discipleship” in Vol. i, p. 115.

‡ Cf. *Rasārṇava* in Vol. i, pp. 64-65.

§ कौटिलिबोधो महारसः—the term वेद्यः has technical meaning. Cf. Vol. i, p. 120.

¶ We are unfamiliar with this name, probably the reading is corrupt.

Tests for *killed* mercury.

The first two couplets are almost the same as in Rasārnava. Cf. Vol. i, p. 74.

When the quicksilver, which has acquired the colour and the lustre of the rising sun, stands the test of fire (*i. e.* is not readily volatilised), then it is to be regarded as *fixed*.

Here follows a list of apparatus borrowed from Rasendramangala—Detailed account of most of these will be found in R. R. S. Bk. ix. *Vide* Vol. i, p. 67.

Chemistry in Rasahridaya of Bhikshu Govinda.

Quicksilver digested with sour gruel and then subjected to distillation is freed from [the impurities of] lead and tin. 1

Much the same as above. 2 * * * *

Description of the apparatus for purification of mercury by sublimation and distillation: it agrees almost literally with that given in R. R. S. Bk. ix, 6 8. *Vide* Vol. i, p. 121.

Pātala vii.

Ingredients for making a *vida* for killing metals. Cf. *Rasārṇava*, IX, 2-3. *Vide* Vol. i, p. 72.

Preparation of mild alkali from the ashes of plants :—

The process must be considered as a poor one, compared to the elaborate description in *Susruta*. Cf. Vol. i, p. 32.

Pātala viii.

* * * Alum, blue vitriol :—all these severally or collectively are favourable for imparting colour to quicksilver. *

Experts [on the properties] of metals are of opinion that tin gives strength, *tikṣhṇa* colour, lead unctuousness, copper all these qualities [to mercury.]

Couplets (in p. 29, Sans. texts) : The purport seems to be that when mercury is rubbed with certain sulphides, *e. g.* orpiment, pyrites &c., and sub-

* The text is not very intelligible. The other ingredients mentioned are *tikṣhṇa* and *kāṇṭa*, these being varieties of iron ; but iron will not amalgamate with mercury. *Tikṣhṇa* may also mean a kind of saline earth. The old alchemists racked their brains in devising ingenious processes for robbing mercury of its fluidity and imparting to it various colours Cf. *Rasārṇava*, IX, 2-3, XI, 197-198. *Vide* Vol. i, p. 74 and also "The Hindu method of manufacturing calomel."—*Ibid.* p. 250.

limed, it assumes the colour of lac or *Coccinella* insect (a poetical and figurative way of expression for red colour) in the shape of the red crystalline sulphide.

Pātala ix.

Vaikrānta, kānta, sasyaka, māṅshika, vimāla, adri, darada, rasaka :—these are the 8 rasas* and their essences are well suited for chemical operations.

Sulphur, gairika, kṣhiti, khechara (mica), añjana, kankuṣṭha :—these are the uparasas. Cf. Vol. i, p. 89.

Gold and silver are the *noble* metals.

Copper, brass, tīkṣṇa and kānta (varieties of iron) are the essential or substantial metals; lead and tin emit foetid odours. Cf. Vol. i, p. 113, footnote (1).

The six salts are :—Sauvarchala, saindhava, chūlika (sal-ammoniac), sāmudra, romaka and vidā. The alkalies are :—Sarjikākṣhāra, yavakṣhāra and borax. (*Vide* Vol. i, Index of subjects.)

Pātala xi.

A cupel made of boneash (goat's) and lined internally with borax &c.

* Cf. Vol. i, pp. 79-81.

Colophon giving an account of the author :—

Madanaratha, King of Kirāta, teacher of mercurial lore, in whom the Goddess of the science of mercury and minerals (Chemistry), the source of all good, has taken her abode for the benefit of mankind, who can restore to the disfigured patient, afflicted with leprosy, the healthy comeliness and lustre of youth :

Bhikshu Govinda, well versed in chemical operations and loaded with honours by the King of Kirāta, composed this tantra entitled “Rasahridaya.”

This tantra is written by Govinda, the grandson of Maṅgalavishṇu and son of Sumanovishṇu :—
May Tathāgata pronounce his blessings.

Chemistry in Kakachandesvari- mata Tantra.

Patala i.

The first patala gives the origin (mythical) of the tantra.

Patala ii.

Kākachandesvari said :—

* * * Please, give a brief account of the

Chemistry of the metals, the killing of mercury and minerals and the fusion of the gems. 3 4

Sri Bhairava said :—

* * * Mercury rubbed with the ingredients of the *vida* (see Vol. i, p. 72) and roasted in a closed crucible, is killed instantly. That mercury now acquires the power of converting a base metal into 1,000 times its weight of gold. 13-16

Copper, treated with the above preparation of mercury and rubbed with the acids, alkalies and the milky juice of *Calotropis gig.*, and roasted in a crucible, turns into gold. 18-20

Earth for making crucibles, 21-22 Cf. Vol. i, pp. 67-68.

Transmutation of iron into gold :—process not clear. 25-32

Patala iii.

Liquefaction of mica :—

Thin plates of mica are to be smeared with the 3 alkalies and borax and strongly heated in a crucible. The whole mass fuses.* * * * 29-30

* Refractory silicates are treated similarly at the present day with the "fusion mixture."

Chemistry in Rasendrachudamani of Somadeva.

Sans. texts, p. 51.

Tests for killed iron (rouge).

As R. R. S. has borrowed these from the present work, it is unnecessary to repeat them here. *Vide* Vol. i, pp. 118-119.

Sans. texts, pp. 52-53.

Take lead of the weight of 30 palas and rub it with the milky juice of *Calotropis gig.* and calcine it till its weight is reduced to a karsha : this residue, even if it be calcined a thousand times, will not undergo further decay (*i.e.* diminution in weight). Metallurgists call this residue derived from lead Chapala.*

Tin also similarly treated will yield a chapala, which, on merely being touched with the hand, kills (fixes) mercury. This mercury is recommended for metallurgical and not for chemical purposes.

* Possibly it refers to lead derived from *argentiferous galena*. The lead, being cupelled off in the shape of litharge, will leave a button of silver, which will not undergo oxidation.

Sans. texts, pp. 53- 4.

[A somewhat complex process described, which is not very clear. We shall try to give the purport thereof. The quantitative measurements are of particular interest.]

1 pala of tin should be taken and rubbed with 10 nishkas of mercury and made into a cake with the addition of zinc ;* it is then to be digested with the decoction of certain herbs and plants and warm vinegar and once more rubbed with $\frac{1}{2}$ pala of blue vitriol † and the juice of *Abrus precatorius*. The mass is then to be divided into small pills ; these should then be put into a crucible with the lid on and the fire to be urged by means of bellows. The essence is then to be taken out of the crucible. This essence of the weight of 10 *Sānas* is then to be enclosed in a mixture of ashes and salts and roasted. This essence of the weight of 2 nishkas is then to be fused with 80 times its weight of lead * * *. This (essence) is also termed chapala. Cf. "the gold-like alloy" in Vol. i, pp. 74 75.

* रसकस्य सस्येन.

† पलाङ्गुलस्य सस्येन.

Sans. texts, p. 55.

When quicksilver has been deprived of its physical properties (lustre, fluidity &c.) it is known as *nashtapishṭa*. Cf. Vol i, p. 74.

Somadeva will now give a brief account of the apparatuses, after having consulted numerous chemical tantras. (Here follows the description, which has been reproduced *verbatim* in R. R. S. *Vide* Vol. i, pp. 121 *et seq.*)

* * * *

Urddhvapātana apparatus as described by Nandin. Cf. Vol. i, pp. 124-125.

Koṣṭhī apparatus as described by Nandin. Cf. Vol. i, p. 69.

Chemistry in Rasaprakasa- sudhakara of Yasodhara.

Sans. texts, p. 57.

Preparation of *karpūrarasa* (lit. camphor of mercury, *i. e.* calomel) : practically the same process as given in Vol. i, pp. 250-51.

[Note. Calomel is prescribed here only as an aphrodisiac and a specific for leprosy but not as a remedy for syphilis.]

Sans. texts, pp 59-61.

Rasaka (calamine) : the author of R. R. S. has evidently borrowed his description of this mineral from the present work. Cf. Vol. i, p. 87.

Extraction of zinc from calamine :

(The process agrees almost word for word with what is given in R. R. S. The essence possessing the lustre of lead runs out of the crucible.*)

Sans. texts, pp. 61-62.

Saurāshī or tuvarī (alum-earth) almost identical with R. R. S. Cf. Vol. i, p. 91.

* * * The essence extracted from the alums (i. e. oil of vitriol) is to be used for operations with metals and not as medicine.

Sans. texts, pp. 62-65.

[Descriptions of various kinds of pits for calcining and roasting purposes are given ; as also their dimensions with the number of cowdung-cakes to be used as fuel &c. Cf. the typical roasting pit in Vol. i, p. 127.]

* * * *

Here ends Chapter X of Rasaparakāśasudhākara by Yasodhara, son of Padmanābha.

* In R. R. S. we have "the essence possessing the lustre of tin."

Sans. texts, pp. 65-66.

Heinakriā or process for the fabrication of gold : "I shall now speak of some curiosities of metals, partly from my own experience and partly from the classics on the subject. Calamine, cinnabar, copper pyrites and realgar are to be rubbed with the milky juice of *Euphorbia nerifolia* for 7 days together and then to be digested another 3 days. Melted copper or silver or lead, being alloyed with the aforesaid mixture, acquires the power of converting 100 times its weight of base metal into gold."* Cf. *ante*, p. 2.

Chemistry in Rasachintamani Of Madanantadeva.

Sans. texts, p. 68.

Svetabhasma : Cf. *ante* p. 16 and also Vol. i, pp. 250-51.

Sans. texts, pp. 69-70.

Two processes for the fabrication of gold :—
much the same as already quoted from Yasodhara.

Process for the fabrication of silver :—

Take 1 part of bell-metal, 2 parts of silver, 4 parts of steel (?) * * these to be fused with

* रातवेधी and सङ्कलवेधी are technical terms ; for the meaning of वेध *vide* Vol. i, p. 120.

tin and borax ;—by this process will be made silver which will pass current for commercial purposes.

Sans. texts, p. 71.

Extraction of zinc from calamine :—

The process is much the same as given above (p. 17), with this difference that, whereas Yasodhara hits off the completion of reduction when the flame issuing from the pot ceases to be blue, the present author directs that the pot is to be taken out of the furnace as soon as white fumes begin to appear. The crucible is then to be held in an inclined position so that the lead-like essence of calamine drops on the ground.

Chemistry in Rasakalpa (Rudra - yamala Tantra.)

Bowing to Siva, the lord of mercury, and also the feet of Chandikā, I write this Rasakalpa, the depository of mercurial lore.

CHAPTER 1.

Tests for *killed* mercury :—

Killed mercury is that which is devoid of (metallic) lustre, not so ponderous, white,* des-

* The author previously refers to the red, black, white and even yellow ash (calx) of mercury ; it is not clear why he should

troyer of metals, divested of fluidity and non-volatile when stirred over a fire. 40 Cf. tests in Rasārnava in Vol. i, p. 74; as also in Rasaratnākara, *ante*, p. 9.

Purified mercury should be preserved in the hollow of a tooth or gem or bamboo. 42

CHAPTER II.

Gold, silver, copper, tin, lead and iron—these are the 6 metals; vartaloḥa, &c., (Vol. i, p. 114) are simply alloys. 1

Honest readers! I beseech you with folded arms to favour my book with your merciful glance.

The mahārasas are 8 in number; *e. g.* mercury, cinnabar, sasyaka, rasaka, &c. ... the rasas are mica, green vitriol and rājāvarta, &c. ... sulphur, orpiment and realgar, &c. are the uparasas as regarded by learned teachers. Cf. Vol. i, pp. 79 and 89.

There are 4 kinds of sulphur:—white, black, yellow and red. Cf. Vol. i, p. 90.

*

*

*

*

here restrict himself to the white variety only. Chloride or sulphide of mercury, when treated with a metal and heated, *kills* (*i. e.* parts with its chlorine or sulphur to) the latter and in that sense it is a destroyer of metals **औद्य**

The saurāshtris (alums) are of various kinds ; the kāsīsas (vitriols) are of 3 kinds,—namely, kāsīsa proper, pushpa kāsīsa and hīrakāsīsa.* Cf. Vol. i, p. 91.

Gairika is stated to be of 2 varieties,—the one of golden hue, the other red ; Kaṅkushtha and other rasas are also described by certain teachers ; but these, however, are not referred to here, as we are treading in the footsteps of sages of old.†

Sans. texts, pp. 75-78

For the purification of mercury this process is recommended by Svachchhandabhairava and Govinda.

Chūlikalavana (Sal-ammoniac), sulphur and the ash of ginger, &c., digested one hundred times with cow's urine,.....make a *vida* for killing gold. Cf. Vol. i, p. 72.

This process for killing [metals] was revealed by Siva and has been transmitted by successive schools of adepts.

* Hīrakasa is the name by which green vitriol is known throughout India; Royle supposes that this word is derived from the Persian *kura* green, and Sans. kāsīsa, (Antiq. Hindu Med.) There is no necessity for looking upon hīrakasa as a hybrid term, seeing that it occurs in the present work in which Mahomedan influence is nowhere traceable.

† Evidently Charaka and Susruta, who mention only a few commonly occurring minerals. *Vide* Vol. i, pp. 29 and 44.

Extraction of the essence of copper pyrites. Cf. Vol. i, pp. 70 and 84.

Extraction of zinc from calamine :—

The process is practically the same as given in R. R. S. Cf. Vol. i, pp. 87 88.

I have performed the [aforesaid] experiments with my own hands and have seen them with my own eyes. They are not recorded from mere hearsay or from the dictation of a teacher. These are being promulgated for the benefit of mankind.

Chemistry in Rasarajalakshmi of Vishnudeva.

Sans. texts, pp. 79-82.

Give an account of the common rasas and uparasas. Cf. Vol. i, p. 79.

Chemistry in Rasanakshatramalika of Mathanasimha, physician to the King of Malwa.

There are several prescriptions given in which mineral preparations play a conspicuous part. We have quoted only two ; in the first, among other ingredients opium occurs ; in the second, the

Svachchhandabbhairavarasa, probably named after the celebrated alchemist, we have the *calces* of tin, iron and mercury along with other drugs.

Chemistry in Rasaratnakara of Nityanatha.

Sans. texts, pp. 84-86.

Test for *killed* mercury :—

When the substance, being heated over a fire of paddy husks, does not further decrease in weight, it should be considered as reduced to a calx.

Purified mercury should be stored in the hollow of a tooth or horn or bamboo.

Directions for making factitious cinnabar (Makaradhvaja). Cf. Vol. i, p. 132 (footnote).

Chemistry in Dhaturatnamala.

In the beginning the author after salutation says : ‘I shall speak of silver, gold, copper, lead, tin and iron as also of calamine, mica, pearls, coral, orpiment, realgar, the pyrites, mercury and diamond,—in fact, the properties of all the metals and minerals and the mode of their incineration.’

Killing of silver. Cf. Vol. i, p. 107.

Chemistry in Rasapradīpa.

Description for preparing mineral acids by distillation :—"Ṣaṅkha-drāvaraṣa or liquid for dissolving conchshells,—practically the same as given under "mineral acids" in Vol. i, p. 186. The last line says : "Cowrie-shells and metals dropped into the liquid are at once dissolved."

Preparation of calomel and treatment of "phiraṅgaroga" (syphilis) with its application. Cf. Vol. i, p. 252.

Chemistry in Dhātukriyā or Dhātumanjari (Rudrayamala-tantra.)

Sans. texts, pp. 98 et seq.

Tin, iron and copper are to be classed among the superior metals.

In general a metal being alloyed with silver is improved in quality. Sattvaja metal (*i.e.* an alloy of tin and copper, *vide* below couplet 15) is of middle quality. 12-14

Synonyms of the different metals. 39-49

Synonyms of zinc : Jāsatva, Yasadāyaka,* rūpyabhrātā (lit. brother to silver), charmaka, kharpara, rasaka, &c. 50-51

* Yasada is the name commonly given to the metal extracted from calamine, *Vide* Vol. i, p. 156

Pittala is an alloy of copper and zinc. 63

Kāmsyalā is an alloy of tin and copper. 65

Zinc being amalgamated with mercury gives rise to rasaka. 68

[*N.B.*—Rasaka and kharpara are the names generally applied to the mineral calamine (*vide* Vol. i, p. 158), but here they stand for the metal (zinc) or its amalgam.]

Lead being killed with the aid of gentle heat gives rise to minium (red lead). 69

Copper in combination with the "burning water" gives rise to tuttha (green vitriol).—Thus manifold operations are performed with the aid of *mantras* and apparatus : all these belong to the province of Chemistry. 70·71

Synonyms of haritāla (orpiment) : Orpiment is a consumer of mercury and also a clipper of its wings.* 79

Synonyms of realgar, cinnabar, mica, &c. 81-89

Synonyms of pearls, coral, tortoise-shell, conch-

* The sulphide of arsenic on being rubbed with mercury and gently heated converts the latter itself into the sulphide. The mercury is thereby *killed* and *fixed* i.e. deprived of its volatility (clipped of its wings—the Hindu alchemist's favourite figure).

shell, tusk of elephants, the tail of the peacock.
90-108

Localities for different metals. 113-121

[The information is very commonplace.]

Localities for copper specified : Nepāl, Kāmārūpa (the eastern portion of Assam), Bangala, † the country of the Mlechchhas, Rūma and the country of the Phirangas, &c. 143-145

Localities for zinc : Kāmboja, Rūma, Balkh, &c.
146

Metals in combination with mercury and sulphur become fit for administration as medicine. 153

* * * *

Process of roasting a substance in a stout glass-vessel using goat-and-cow-dung-cakes and husks of paddy grains as fuel. 9 10

One part of gold and four parts of zinc are to be melted together and the alloy roasted in a closed crucible . . . the process repeated with the addition of alkalies : . . . gold of a reddish yellow colour will thus be generated. 11-17

* All these have been placed under the category of (हीन) inferior dhātu. Though the term dhātu generally means a metal, it is often applied to a mineral ; here, however, it covers a much wider field.

† This is the name given to Bengal in many Tantras.

A process for making factitious cinnabar by pouring mercury into its own weight of molten sulphur and then adding three-fourths its weight of orpiment . . . The mass to be rubbed in a mortar and subjected to sublimation. 23-30

By using the *augmented** gold as a means of exchange one can amass wealth. 52

Tin is to be melted and one-hundredth part its weight of mercury to be amalgamated with it. This [fraudulent substitute for] silver can be used for purposes of exchange, and one can thus amass wealth. 85-86

Pure gold is to be alloyed with one hundred times its weight of copper and this [imitation] gold will resemble native gold. 88

Lead and copper being alloyed together will give rise to gold. 97-98

Colophon : Here ends the Chapter on the extolling of gold in Rudra-yāmala.

* Cf. footnote, p. 2.

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* Cf. footnote, p. 2.

Chemistry in Suvarnatatra or Svarnatantra.

The origin of the tantra is explained in the opening lines. Parasurāma having given away his worldly possessions to Kasyapa is rendered destitute, and thus has to invoke the aid of the God Siva for his very maintenance.

Siva said : Listen ! I shall now reveal to you the most wonderful mysteries of Svarnatantra, 1-10

A kind of oil is exuded from the bulbous root of a plant ; all around it within a radius of ten cubits oily water is exuded and a venomous snake lives under it. If you want to test the properties of the bulb, you should thrust a needle into it, and the needle at once dissolves. Having procured this bulb, rub it with mercury in a mortar and add the oil and subject the mixture to heat in a crucible. The mercury is at once *killed* and acquires the property of converting one hundred thousand times its own weight of the base metal into gold.* I4-18

Pure orpiment is to be rubbed with this oil for 20 days, and the former is killed thereby and loses its volatility. The 8 metals in the molten state being treated with this prepared orpiment acquire

* लघवेद्यो भवेत्.

the power of transmutation. When the above oil is thrown into molten copper, it is turned into gold of beautiful lustre. Tin and bell-metal similarly treated are turned into silver, and copper, iron, brass and silver into gold. 19-24.

Saṅkhadrāvaka (*aqua regia*, see *ante* p. 24) is spoken of as an universal solvent This solvent with mercury is to be placed in a glazed crucible and subjected to heat; the mercury, thus *killed*, can convert the 8 metals into gold. By partaking of this mercury one becomes immortal; even his urine and fæces can convert copper into gold.* 1-10

* This sort of belief was prevalent also at the time of the composition of Rasārṇava.

Knowledge of Gems.

A few words on gems may not be considered beyond the scope of the present work especially as the subject has already drawn the attention of some European scholars.* We shall, however, limit ourselves, as far as possible, purely to the physical and chemical properties of the precious stones.

It has already been seen that among the 64 branches of arts and sciences recognised in the ancient 'Kāmasūtra' of Vātsyāyana occur the following :—(a) the testing [of the genuineness or otherwise] of gold and the gems ; (b) knowledge of the colouring of gems, as also of mines and quarries.† Varāhamihira (d. 587 A. D.) in his "Vṛihat Samhitā" also conveys much useful information on this subject, but as he in his turn refers

* Garbe in his "Indischen Mineralien" (Leipzig, 1882) gives the text and the translation of Ch. xiii of Narahari's "Rājani-ghantu" ; this work, however, is comparatively modern. Much useful information on the subject with bibliographical references will be found in Professor Yogesa Chandra Rāy's treatise in Bengali entitled "Ratnaparikshā."

† *Vide* Vol. i, p. 191.

to experts who preceded him,* it may safely be concluded that long before this time it received adequate attention.

The Garudapurāṇa under the heading of Ratnaparikshā (examination of the gems) devotes several chapters to a detailed and fairly exhaustive description of the gems. This Purāṇa like so many of its class discusses on a variety of topics, mundane and spiritual ; in short, it may be looked upon as a sort of *multum in parvo*.

From time immemorial the gems have been valued in India not only for purely decorative and ornamental purposes, but also as agents for warding off perils and the malignant influences of the planets and for securing luck and longevity. Hence it is that particular attention is paid to the testing of gems, as their virtue increases in proportion as they are faultless and flawless.

The typical characters which were most relied upon for differentiating one species of a gem from another were (1) the relative weight, (2) hardness, (3) lustre, transparency and colour, (4) fusibility, especially when heated in combination with the alkalies. It will be noticed that even the lapidaries

* पूर्वजाचार्यैः समुद्दिष्टं

and the mineralogists of the present day have to depend largely upon these properties in the classification of the *stones*. We shall now proceed to say a few words under each of the above characters following in the main the authority of *Garudapurāṇa*.

1. **RELATIVE WEIGHT.** We have purposely used these terms as contradistinguished from "specific gravity": as the latter connotes peculiar associations. The principle of Archimedes being evidently unknown among the Hindus, the measurement of volume could only be roughly approximate. To cite some illustrations. A stone may be of the same species as, and equal in volume to, a *padma-rāga* (oriental ruby), but will differ in weight from the latter.*

Empirical and arbitrary scales of weight were adopted as standards. A ruby occupying the volume of a *guñja* (*abrus precatorius*) may be equal in weight to 10. 7 and 3 *guñjas* respectively. A ruby of the volume of a *śrigālakola* (a kind of jujube) should weigh 12, 8 and 7 *guñjas* respectively. Again, a ruby of the volume of an *āmalakī* (*phyllanthus emblica*) should weigh 30. 20

* तुल्यप्रमाणात् न तुल्यजातेर्वा वा भुङ्क्तेन भवेत् तुल्यः ।

and 16 māshās respectively.* In each case the gem which is of greater weight is superior in quality and the value thereof is enhanced in proportion.†

In the case of precious metals, however, adulteration was detected by an ingenious device, which may be regarded as a near approach to the principle of Archimedes. Suppose it is intended to test the purity of a specimen of gold. All that one has to do is to draw a wire of this gold and another of the standard gold through the self-same orifice [of corundum]. As these wires are of equal

* We give below the standard weights as current at the time of Varāhamihira.

8	White mustards	...	=	1 tandula (a grain of paddy)
4	Tandulas	...	=	1 gunja (<i>abrus precatorius</i>)
5	Gunjas	..	=	1 Māshā
16	Māshās	..	=	1 Karsha or suvarna or tolaka
4	Karshas	...	=	1 pala

The standard of weight has always varied in different times in different parts of India. 10 gunjas weigh about 18 grains. The seeds often vary in size.

† Garuḍa lays special stress on the high specific gravity (=4.0) of a genuine ruby. लघुत्वं विज्ञातिलिङ्गं, again गुह्यत्वं मन्त्रीणां गुणसंयङ्गः। While high specific gravity is indicative of the excellence of the gems in general, in the case of diamond it is just the reverse. गुह्यता सर्वैरज्ञानां गौरवाधानकारणम् । वज्रं तत् वैपरीत्येन सूचयः परिचक्षते ॥ It is not easy to account for this qualifying clause, seeing that diamond has a sp. gr. of 3.5.

diameters, equal lengths will have equal weights, provided the sample is pure.*

2. **HARDNESS.** There are many stones which in external appearance resemble a ruby ; the spurious substitute may easily be detected by its difference in softness (low degree of hardness), and low specific gravity : again in case of suspicion the gem is to be rubbed on a whetstone ; if it simply gains in lustre but does not lose in weight (by abrasion), the specimen is to be regarded as genuine (test of a ruby).† Diamond and corundum alone will scratch ruby and sapphire. Skilful lapidaries often make imitation diamonds of zircon, ruby, cat's-eye, rock-crystal and glass ; hence they are to be tested by calling in the aid of learned experts. All the gems occurring in this world as also the metals will be scratched by a diamond, but the latter will not be similarly affected by the former.A diamond alone will scratch a diamond.‡

* एकच्छिद्रे समाकृष्ट समखण्डे इतीयंदा ।

शाली: सूचं मानसमं निर्दुष्टस्य भवेत्तदा ॥ Sukranāsti.

† This is true in a qualified sense only. After the diamond corundum is the hardest of all known minerals.

‡ The ruby and the sapphire are only varieties of corundum. Varāha classes corundum as a species of ruby, the former being dotted over with black and white patches and feeble in lustre [i.e. the non-transparent or course kind]. It is scarcely necessary to

To the above tests Rājanighantu adds another, namely, when a diamond is struck with an iron hammer, it is not broken to pieces*

point out that the very word "corundum" is derived from the Hindi *kurand*, a corrupt form of the Sanskrit *kuruvinda*. The statement "corundum will scratch ruby and sapphire" is not strictly accurate. There are degrees of hardness among the different varieties of corundum, the blue sapphire standing first in this respect.

We give here the original texts of which we have given above almost a literal translation.

"लेहप्रभेदो मदुता लघुत्वं विजातिलिङ्गं खलु सार्वजन्यम् ।"

"अप्रचक्ष्यति सन्देहे शिखायां परिघर्षयेत् ।

वृष्टा योऽन्यन्तशोभावान् परिमाणं न मुञ्चति ।

स ज्ञेयः शुद्धजातिस्तु ज्ञेयाद्यान्वे विजातयः ॥"

"वज्रं वा कुरुबिन्दं वा विमुष्यान्वेन केनचित् ।

न शक्यं स्खलनं कर्तुं पद्मरागेन्द्रनौलयोः ॥"

* The reading of the text is very corrupt. Garbe gives as many as 12 variants; that adopted by him seems to be on the whole reliable as also his rendering: "Wenn er mit anderen steinen oder eisernen Hammern geschlagen nicht zerspringt." On account of its brittleness a diamond will readily be shivered into splinters under the blow of a hammer. The following extract from Bauer and Spencer's "Precious stones" (pp. 129-130) may prove of interest.—

"The hardness of diamond has often been confused with its fragility or brittleness. It has been supposed, especially in ancient and mediaeval times that hammer and anvil may be shattered but not the diamond which lies between.

3. LUSTRE, TRANSPARENCY, COLOUR and other optical properties. Difference in lustre (चेदप्रभेद) is often regarded as a diagnostic feature of the gems. According to Varāha gems of superior qualities should possess cool (lit. waxy) lustre, be limpid and emit rich rays. Classification according to colour is often enjoined. For instance, a diamond may be perfectly colourless, or it may be yellow,

This statement was made by Pliny, the great naturalist of ancient days, who was killed in 79 A.D. at the first historic eruption of Vesuvius. He proceeded to say further that the fragmentation of a diamond may be effected by subjecting it to a preliminary immersion in the warm blood of a goat, but that even under these circumstances the hammer and anvil will also be broken ! According to Albertus Magnus (1205-1280) the blood is more efficacious if the goat has previously drunk wine or eaten parsley.

“Such being the views then held respecting the unbreakable and indestructible character of the diamond, it is easy to understand why the Greek word *adamas*, signifying unconquerable, should have been applied to this stone, although its application to the diamond is singularly inappropriate and inaccurate when its extreme fragility is considered. Many a doubtful stone has been submitted to the test of the hammer, with the belief that the blow would be resisted only if the stone were a genuine diamond. Probably many beautiful stones have been sacrificed to this old belief. As a matter of fact, diamond is easily fractured, a very moderate blow from a hammer sufficing for the purpose ; its perfect cleavage places it among the most brittle of minerals.”

black, red or copper-tinted.* Stones which are translucent, opaque and of dull colour are inferior in quality. In the case of diamond special stress is laid on its displaying the colours of the rainbow [due to its high dispersive power]. Some gems have only one shade of colour (एकवर्ण) others again two (द्विवर्ण)†

The changes in colour which the ruby and the sapphire undergo under the influence of heat had evidently been carefully observed. This test is to be applied with extreme caution as in case the pro-

रक्त पीतं चितं शैरीषं (Varāha) वाताक्षं (Garuda).

Yellow diamonds are unknown in India at the present day at any rate. "India can claim for its own all the finely coloured stones of blue, green and red, not however, yellow diamonds, which come mainly from South Africa." (Bauer and Spencer). Crystals of black diamond should not be confounded with the black carbonado.

† Probably refers to dichroism. As has already been pointed out the red ruby and the blue sapphire are only varieties of corundum, which often occur in well-developed crystals belonging to the rhombohedral division of the hexagonal system. "The dichroism of the ruby affords a means whereby it may be distinguished with certainty from other red stones, such as spinel and the different varieties of garnet, which crystallise in the cubic system, and thus being singly refracting can show no dichroism." (Bauer and Spencer). "The dichroism of the sapphires of Siam is specially well marked."—*Ibid.*

per degree of temperature अप्रिमाणा is exceeded, the stone may be materially injured.*

4. FUSIBILITY (LIQUEFACTION). It was well-known that all the gems with the exception of diamond would undergo liquefaction when strongly heated with a mixture of the two alkaline carbonates [now familiar in the Laboratory as the "fusion mixture"]. The liquid principle of gems रज्ज्वा द्रुति was a favourite remedy with the Hindu Iatro-Chemists (Cf. Vol. i, p 103). As most of the precious stones belong to the corundum and the spinel group, they easily yield to treatment with sodium and potassium carbonates. In the case of the pearls it is recommended that they should be enclosed inside lemons and placed in a mass of paddy grains [for the sake of the warmth].

* यावन्तं चक्रमेदिष्टं पद्मरागोपधीगतः (१) ।

इन्द्रनीलमणिस्तज्जात् क्रमेत सुमहत्तरम् ॥

तद्यापि न परीक्षाये गुणानामभिद्वन्द्वये ।

मणिरघौ समाधेयः कथञ्चिदपि कथन ॥

अप्रिमाणा(ऽ)परिज्ञाने दाहदीपैश्च दूषितः ।

सोऽनर्थाय भवेद्भर्तुः कर्तुः कारयितुस्तथा ॥ Garuḍa.

Cf. "The red ruby, at a high temperature, is colourless : on cooling it first becomes green, after which it gradually assumes its original fine red colour." (Bauer and Spencer). "The blue colour of the sapphire disappears on heating."—*Ibid*.

GENERAL AND CONCLUDING REMARKS.

The crystalline character of the minerals is referred to in one or two places. All the old writers agree in describing the diamond as having 6 angles. 8 faces and 12 edges.* The octahedral form of the crystal is common in the diamond occurring in the neighbourhood of Panna in Bundel Khand. Rājānighantu further adds that the stone is often endowed with numerous faces and edges.† According to *Rasaratnasamuchchaya* the female diamond is flattened and rounded whilst the neuter is rounded and obtuse-angled ‡ *Vaikrānta* is also

* कोट्यः पार्श्वानि धाराश्च षडष्टौ वादशेति । *Garuda*.

† "In most cubes of diamond, however, each edge is replaced by two faces,.....the twenty-four faces thus derived would, if produced or enlarged" sufficiently, give rise to the form known as the four-faced cube, or tetrakis-hexahedron. (Bäuer and Spencer).

‡ The rendering of the description of diamond in R.R.S. (*vide* Vol. i, p. 100) is based upon a misreading. The correct reading is that adopted by the Poona edition, namely, षट्पक्ष षट्फलकं षट्कोणं "a diamond has 8 faces and 6 angles." The author evidently uses पक्ष and फलक in the same sense ; there cannot be any confusion here, as distinct mention is made of the 6 angles. As a rule पक्ष and कोण are used synonymously. Thus in *Varāha* वज्र is described as षडक्षि ; the commentator *Bhaṭṭotpala* explains it षड्भिरक्षिभिर्युक्तं षट्कोणमित्यर्थः । "Rounded" (वर्तुल) ; Cf. *Bauer and Spencer*. "The faces of diamond crystals differ from those of most other crystallised minerals, in that they are as a

(probably a mineral of the spinel group. *vide* Vol. i, p. 83) described as having 8 faces and 6 angles.

It is sometimes asserted that the phosphorescence of diamond was first observed in 1663 A. D. by the celebrated Robert Boyle. Bhoja (11th century A.D.), however, mentions this property.* Faults in precious stones due to isolated grains of minute gravels etc., embedded in the mass [now technically called "enclosures"], are also referred to.†

It may be noted here that what is generally known as the Indian or Tavernier's rule for determining the value of diamond can be traced back to a remote date. Sukranīti speaks of it as the "rule of squares,"‡ while Varāha, himself a great rule, much curved and rounded instead of being perfectly plane as is usually the case." p. 119. "Obtuse-angled" (कुण्डकोणाय) in the crystallographic terminology should be rendered as "with corners truncated off."

* अन्धकारी च दीप्यते (phosphoresces in the dark).

† कलुषा मन्दद्युतयो लेखाकीर्णाः सधातवः खण्डाः ।

दुर्विद्धा न मनोज्ञाः सशर्कराश्चेति मण्दिदोषाः ॥ Barāha.

Here सधातवः and सशर्कराः no doubt refer of the minute pebbles (gravels) enclosed in the body of the stones.

‡ यथा गुह्यतरं वज्रं तन्मूल्यं रत्निवर्गतः i. e. if a diamond weighing 1 *rati* be worth *x*, one of the weight of 4 *ratīs* will be worth 2 *x*.

mathematician, gives practically the same rule, though somewhat on an elaborate scale.*

It would be unfair to compare the progress made by the Hindus in this branch of knowledge in the 6th century A.D. and perhaps earlier with that of the present day. Reference to the crystalline forms of diamond can be found in the writings of Keppler, Steno and Robert Boyle in the seventeenth century. Scientific crystallography originated with Romé de l'Isle and the abbé Haüy at the end of the eighteenth century. The various physical and chemical properties of the minerals culled here bespeak considerable powers of keen observation.†

i. e. if a diamond weighing 20 *tandulas* (p. 33 *ante*) be worth 2 lacs (2,00,000), one weighing 5 *tandulas* will be worth only ($5 \div 4 = 100$)th part of 2 lacs or 2,000.

† Concerning Ratnaparikshá cf. also "Les Lapidaires Indiens" by M. Finot in the "Bibliothèque de l'École des Hautes Études."

NOTE ON THE METHOD OF PREPARING CAUSTIC ALKALI.

In the first Volume of our History the detailed description of preparing caustic alkali from the ashes of plants has been quoted at length from the *Susruta* and we referred to it "as a proof of the high degree of perfection in scientific pharmacy achieved by the Hindus at an early age."* M. Berthelot has no less been struck with the originality of this process; indeed, he goes so far as to suggest that this portion in the *Susruta* is evidently modern and in fact a later addition derived from contact with the European chemists.†

The process of rendering mild alkali caustic by the addition of lime is to be found also in *Chakrapāni* (c. 1050 A. D.) and *Vāgbhata*, who must have preceded the former by several centuries, and it is well known that both these authors are deeply indebted to the *Susruta*. There is not thus the remotest chance of inspiration from the European chemists.

* *Vide* Vol. i, Intro. c.

† *Journal des Savants*. Jan. 1903, p. 42.

We have evidence from quite an unexpected and independent source that the cauterization of bad wounds by means of caustic alkali was an established custom in ancient India. Thus we read in "The Questions of king Milinda" :—

"And when the inflammation had gone down, and the wound had become sweet, suppose he were then to cut into it with a lancet, and burn it with caustic. And when he had cauterized it, suppose he were to prescribe an alkaline wash Now tell me, O king ! would it be out of cruelty that the surgeon . . . , . thus cut with the lancet and cauterized with the stick of caustic."*

* "Sacred Books of the East," Vol. XXXV, p. 168.

Although Milinda has been identified with the Bactrian Greek king Menander (c. 140—110 B. C.), it is not to be supposed that any Greek influence can be traced in it. In this ethical romance, king Milinda and the Buddhist Bhikshu Nāgasena have been put forward simply "as men of straw" to quote Rhys Davids. The work in reality conveys the teachings of the older Buddhists (Hīnayānists) with the background of Sāṃkhya and Vedānta metaphysics.

The Tantrists, the Rosicrucians and the seekers after truth.

The East has not been always East and the West, West. Modern Europe is materialistic, but she has not disdained in the past to "plunge in thought." This reminds us of the truth of the poet's words: "one touch of nature makes the whole world kin." Ancient Greece had her orphic mysteries. They were developed into a religious and ethical system by Pythagoras. In the schools of Alexandria the neo-Pythagoreans and the neo-Platonists further added to it the Vedantic doctrine of a world-soul.

"With the dissolution of the neo-Platonic school in the sixth century, Greek philosophy disappears, it is true, as distinct phenomenon from the theatre of history, but it continues to exist in combination with foreign elements in the service of a new form of culture in the Science of the Middle Ages and of modern times." (Zeller).

Says Waite :—

"The traditions of the new-Platonic philosophy, with its elaborate theurgical system, were to some extent perpetuated through the whole period of the Middle Ages, for besides the orthodox theology of the great Latin Church and amidst the clamour of scholastic philosophy, we find the secret theosophy of the magician, the Kabbalist, and the alchemical adept borrowing, directly or indirectly, from this prolific

fountain of exalted mysticism. The traces of its influence are discoverable in Augustine, in Albertus Magnus, in St. Thomas, the angel of the schools, and in other shining lights of western Christendom, while the metaphysical principles of Johannes Scotus Erigena, even so early as the close of the ninth century, were an actual revival of this philosophy."*

History repeats itself. In India the Yoga doctrines of Patañjali paved the way for the origin of Tāntric mysticism and it associated itself with magic and alchemy. Some twelve centuries later, this phase in the stage of human progress found exponents in the soil of Europe. As Waite says :—

"In an age of progress, of doubt, and of great intellectual activity, it is singular to remark the almost invariable prevalence of mysticism in one or other of its manifold phases, and the close of the sixteenth century beheld spreading over the whole of Germany and passing thence into Denmark, France, England and Italy, a mighty school of mysticism in the great multitude of magicians, alchemists, &c., who directly or indirectly were followers of the renowned Paracelsus."†

*"History of the Rosicrucians," p. 27. Regarding the sect of the Cabalists see also Lecky's "Rationalism in Europe." Vol. i, p. 42. ed., 1900.

† See also Kopp's "Die Alchemie in ält. u. neu. Zeit," ii, pp. 1—146, on the "Bekantschaft mit Geheimnissen der Magie, Theosophie, Alchemie u. A."

Even the lower strata of society in England did not escape the contagion. Sir William Temple observes : "I have had several servants far gone in divinity, others in poetry, have known in the families of some friends, a keeper deep in the Rosicrucian mysteries."

There are those who sneer at the attempts of the alchemists to convert the baser metals into gold and are at the pains to insinuate that the motives of the adepts were sordid. It may be that there have been here and there men—vulgar charlatans—who have pursued the *art* merely from worldly considerations. The high priests of alchemy, however have in every age and clime been honest seekers after truth. Had there been no desire implanted in the human breast to pry into the hidden and occult mysteries of nature there would have been no science. Whence come we and whither are we destined to go? What is this substance made up of, and what are its ultimate constituents, and what will its combination with this or that lead to? These are queries, the solution of which or rather the very attempts to solve which mark the birth of philosophy. Patañjali and Nāgārjuna in India and Paracelsus in Europe stand forth as the prominent representatives of

this spirit of inquiry. They have been dreamers, mystics and naturalists all combined in one. Such geniuses have always chafed at the restraints and limitations imposed on frail man and hence their fervid yearnings to peep into regions beyond the ken of our gross senses. As Emerson puts it :—

“The privilege of this class is an access to the secrets and structure of nature, by some higher method than by experience. In common parlance, what one man is said to learn by experience, a man of extraordinary sagacity is said, without experience, to divine.”*

Plotinus heaved a sigh at the soul with its infinite possibilities being caged in a frail and corruptible body. The pursuit of alchemy by the esoteric *Tantrist* is easily explained. To him it was only a means to an end. “It (mercury) is alone that can make the body undecaying and immortal.”† We find echoes of the same sentiment in the authoritative literature of the Rosicrucians,

Says Waite :—

“Among the concourse of inquirers, and the clamour of supposed and pretended discoverers, there rose gradually into deserved prominence an advanced school of illuminati,

*“Swedenborg ; or, the mystic.”

† *Vide* “History of Hindu Chemistry,” Vol. i. Intro. lxxvii and xcv—xcvi.

who, employing the terminology of the *turba philosophorum*, under the pretence of alchemical pursuits appear to have concealed a more exalted aim. . . . The student is directed by these writers from the pursuit of material gold to the discovery of incorruptible and purely spiritual treasures. . . . Physical transmutation, the one and supreme end of the practical alchemist, sinks into complete insignificance; nevertheless, it is performed by the adept and is a landmark in his sublime progress." l. c. p. 32.

The sage and seer of Hoenheim had his wrestlings. Should he pursue knowledge for its own sake or for what it bringeth? His evil genius holds out the bait thus :—

"Know not for knowing's sake
But to become a star to men for ever ;
Know for the gain it gets, the praise it brings,
The wonder it inspires, the love it breeds."*

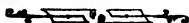
The spiritual at last triumphs over the base in man. Paracelsus has his revelation, and he bursts forth :—

"Truth is within ourselves : it takes no rise
From outward things, whate'er you may believe,
There is an inmost centre in us all
Where truth abides in fullness : and around
Wall upon wall, the gross flesh hems it in,
The perfect clear perception—which is truth."*

* Browning's "Paracelsus."

In the above delineation the poet has done no more than bare justice to the inward longings of an ideal alchemist, who is only an honest seeker after truth. The spiritual and thought-world has always transgressed all barriers of time and space. Kanāda, Patañjali and Nāgārjuna of India and Heraclitus, Empedocles and Plato and the rest—they all form a holy fraternity ; aye, these prophets and oracles of the intellect belong to a “lofty and sequestered class,” “the high-priesthood of the principles of thought from age to age. When at long intervals we turn over their abstruse pages, wonderful seems, the calm and grand air of these few, these great . spiritual lords, who have walked in the world,—these of the old religion,—dwelling in a worship which makes the sanctities of Christianity look *parvenues* and popular ; for ‘persuasion is in soul, but necessity is in intellect.’ ”*

* Emerson : on “Intellect.”





The metals and their loss in weight after calcination.

Very vague ideas prevailed among the Hindu philosophers on the constitutions of a metal and its fate after calcination. We are reminded of the diversity of opinion in Europe before the time of Lavoisier. A metal like every material substance was supposed to be formed of one or more of the five, *bhūtas*; in fact the earthy or saline element was taken to be predominant in it,* and hence it lent itself so readily to calcination. † It should be noted here that by “*bhūta*” was understood not so much an *element* in the modern connotation of the term as certain qualities of individual substances. Even mercury was regarded as composed of the five *bhūtas*. ‡ When a metal was submitted to calcination some of its component *bhūtas* escaped, leaving the earthy or saline portion behind; hence the ash (*calx*) must weigh less than the original metal itself

* पार्थिवः सुवर्चरजतमहिमुक्तामनःप्रियासुतकपासादयः । Ch. 1., 4. 2
Again in Ch. XLVI (Sūtra) 345 et seq. the metals are included among the saline ingredients.

† Cf. “For some maintain that gold is solid light, or, at least that the chief ingredient is light, which is rendered solid by mixture with some particles of earth. *Were it more earth it might be calcined by fire strongly urged.*—Vol. 1. P. 9.

‡ पञ्चभूतात्मकः सुतण्डुलत्वेन कदाचिद्विदुः । इति रसायने ।

There is, however, no direct reference to be met with anywhere as regards the quantitative aspect of the question so clearly established by Lavoisier.

The proportion of loss which a metal undergoes on ignition was made the basis for determining its purity and we find in the law-books an arbitrary scale fixed. Thus according to Yājñavalkya, "gold is unaffected by fire, while one hundred parts by weight of silver, tin and copper lose (lit. undergo decay to the extent of) two, eight and fifteen parts respectively.* This is to be taken as referring not to the roasting (killing) of a metal but simply as allowance made to goldsmiths and other artisans for loss incurred in the shape of dross &c. when it is melted in a crucible.

That copper, lead, tin and other base metals (हीनधातवः) when repeatedly calcined are completely reduced to their calces was well known as will be seen throughout the body of the texts. The passage from Rasendra-chūdāmaṇi (p. 14) deserves some notice. Lead of the weight of 30 *palas* is to be calcined till its weight is reduced to a *karsha* ($=\frac{1}{4}$ *pala*). Even if it be calcined now one thousand times, it will not undergo further reduction in weight. Our author evidently had his experience of lead derived from argentiferous galena, which would leave

* अष्टौ सुवर्चनवीचं द्विपलं रजते श्रते ।

अष्टौ त्रिपुचि-वीचि च तावत् पञ्चदशश्रति ॥

a residue in the shape of a "button" of silver after the lead had been cupelled off. *

* Similar confusion prevailed in Europe up till the end of the 17th century. The following extract from Robert Boyle's "Concerning the Unsuccessfulness of Experiments" will make the point clear.

"Having, upon occasion, had the curiosity not long since to visit some mines of lead and other metals, I find that there is a great difference, and discernible even to the eye, betwixt the several ores ; for instance, of lead, some of which I can show you so like steel, and so unlike common lead-ore ; that the workmen upon that account are pleased to call it steel-ore, which being of more difficult fusion than ordinary, they are wont to mix it with other ore, which they call firm-ore, to facilitate the melting of it. And I likewise took notice of an ore, which for its aptness to vitrify, and serve the potters to glaze their earthen vessels, the miners call pottern-ore, and sell it (at least where I saw it digged up) dearer than other ore, from which it differs both visibly enough, and as the workmen affirm in divers other (and those less obvious) qualities ; and yet all these ores, after fusion, do pass indiscriminately under the name and notion of lead. In which therefore it is no wonder, that severer inquiries find a great deal of disparity. I remember I did not long since cause some lead-ore to be tried, which being the most promising that ever I saw, made me suppose it might contain some considerable quantity of silver : but though it proved so rich in lead, as to yield after the rate of seventy pound to the hundred, yet one of the most expert artists in Europe could not extract one grain of silver out of it ; whereas the lead of very many mines, being skilfully examined, will leave behind it, upon the test, a proportion of pure silver. And though this quantity of silver be not considerable enough to make such mines as yield it pass for silver mines

Antimony.

Although there is no direct recognition of antimony as a distinct metal, some sort of allusion to it as a variety of lead is not wanting. The reason why antimony was often confounded with lead is that at first sight stibnite may be mistaken for galena. The mineral *sauvīrāñjana* or *nilāñjana* was thus indiscriminately applied both to the sulphides of antimony and of lead (cf. vol. 1., pp. 93-95). That *nilāñjana* contained a new metal was often suspected though its nature was not properly understood. Thus in *Rasendra-chūdāmazi* we have "*nilāñjana*, mined with *tikshṇa* (cast iron), and heated several times yields a superior kind of lead which is readily fusible and is of mild black colour. *

(or, as we are wont to call them mines-royal) because the silver will not quit the cost of extracting it ; yet such mines though they pass but for lead mines with the metalist, may appear to be mixt mines to the naturalist, who may meet with divers experiments, wherein the little silver that is in them, may make their lead operate differently from that of those ores, which are wholly destitute of silver."—Edition of 1772, p. 323.

* *Vide Sans texts*, p. 52. The identical distich occurs also in R. R. S. Cf. vol. 1 p. 119. Cf. also "But to detain you no longer on the subject, give me only leave to strengthen the paradox I have proposed, by the authority of that great and candid chymist *Basilus Valentinus*, who speaking of antimony, after he hath told us, that there are several kinds of it, and especially two ; the one more mercurial and of a golden property, witnessed by the shining streaks or beams it abounds with ; the

The preparation known as Svarnasindura or makaradhvaja.

As the "law of definite proportion" was unknown to the ancients, tedious processes were resorted to for the complete conversion of mercury into its sulphide. "Makaradhvaja" even at the present day is a favourite remedy with the Hindu physicians of the A'yurvedic school.* Let us follow the recipe as given in Rasendra chintāmaṇi : "when quicksilver is killed with an equal weight of purified sulphur, it becomes hundred times more efficacious ; when it is killed with twice its weight of sulphur it cures leprosy ; when it is killed with thrice its weight of sulphur it cures mental langour ; when it is killed with four times its weight of sulphur it removes grey hair and

other more full of sulphur, but destitute of the golden nature that enriches the former ; adds, that there is such a different goodness betwixt the several sorts of antimony, as there is betwixt the several sorts of flesh or fish, which, though agreeing in name and, if you please, in nature, do exceedingly differ in point of goodness, which brings into my mind the great difference which I have found, even visible to the eye, betwixt the several sorts of Antimony."—Boyle's work—I.c. p. 324.

* If we take the historical meaning of the term "A'yurvedic," the above preparation cannot lay claim to this distinction, for it was unknown at the time of the Charaka and the Susruta and was introduced into the Materia Medica during the Tantric period.

wrinkles; when it is killed with five times its weight of sulphur it cures consumption; and when it is killed with six times its weight of sulphur it is a panacea for all the ills that flesh is heir to.* Now 25 parts by weight of mercury can only take up (*i. e.* combine with) 4 parts by weight of sulphur; the excess of sulphur simply sublimes off unchanged. In the actual preparation of *svarna-sindūra* (Lit. vermilion with gold) the mercury is first made into an amalgam with thin gold leaves and then repeatedly rubbed in a mortar with sulphur. During the process of sublimation (*ऊर्ध्वपातन*) the excess of sulphur volatilises off as we have already explained and the gold in fine particles remains behind as a residue. The lustrous, crystalline, reddish brown sublimate, which collects nearest the source of heat,† has the formula HgS . As there is an erroneous impression about

- * तुल्ये तु गन्धके जीर्णे शुद्धाच्छतगुणो रमः ।
 त्रिगुणे गन्धके जीर्णे सर्वकुष्ठहरः परः ॥
 त्रिगुणे गन्धके जीर्णे सर्वजायविनाशनः ।
 चतुर्गुणे तत्र जीर्णे वस्त्रोपलितनाशनः ॥
 गन्धे पञ्चगुणे जीर्णे चयि चयहरी वनः ।
 षड्गुणे गन्धके जीर्णे सर्वरीगहरी रसः ॥ र, च.

† Gopālakrishna very properly lays particular stress upon this point.

स्कीटविला तु मुक्ताममृदुलपं वलिं मज्जित् ।
 चचःसं रससिन्दूरं सर्वरीगेषु बीजयेत् ॥ इति रसेन्द्रसारसंग्रहः ।

the composition of this drug even among educated people in this country we give below the results of analysis of a sample of "mercury killed with six times its weight of sulphur along with gold."*

Identification of metals by their colouration of flames.

Prominent attention should be drawn to the following extract from *Rasārnava* (Vol. I., p. 68.)

"Copper yields a blue flame * * * * *
that of the Tin is pigeon-coloured ; that of the Lead is pale-tinted"

We are not aware of similar tests being applied anywhere at such an early period as a qualitative test for metals.

The age of Bhīkshu Govinda the author of *Rasahrīdaya*.

There is a belief current in some parts of the Deccan that our Govinda is no other than the celebrated teacher of *Saṅkarāchārya*. † If there be any historical foundation for the belief Govinda

* Percentage of sulphur found = 13.89 ; the calculated amount being 13.79 ; not a trace of gold could be detected.

† The following *Slokas* are cited from *Saṅkaradigvijaya* in support of the above :—

तस्योपदर्शितवतश्चरन्तो गुह्याया हारी नृपूजयद्दुषेत् स शंकरार्यः ।
आचार इत्युपदिष्ट स तच्च तस्मै गोविन्दपादगुरवे न गुरुर्यतीनाम् ॥

should no doubt be placed in the 8th century A. D. Apart altogether from the question whether at such an early date the progress of chemical knowledge as revealed in *Rasahridaya* had been attained in India, the colophon at the end of the work would tell against such an hypothesis (Intro. liii). The author distinctly states that he wrote his book under the auspices of the king of the *Kirātas* and even throws out a hint that he was of the Buddhist persuasion. We have no valid reasons to believe that *Saṅkara*, the sturdy champion of Brahminical faith and the mighty dialectician, whose activity proved the ruin of Buddhism in India should have sat at the feet of a Guru of the opposite creed.

व्यासः पराशरसुतः किल सत्यवत्या तस्यात्मजः शुक्लमुनिः प्रथितानुभावः ।

तार्क्ष्यतामुपगतः किल गौडपादो गोविन्दनाथमुनिरस्य च शिष्यभूतः ॥

यथाव तस्य निकटे किल ब्राह्मजालं * * * *

श्रीमच्छंकरादिविजयः, ५मसर्गः, verses १०१ and १०५-६ ।

बालन्यायमसंस्कृतयथावलिः—यन्त्राङ्कः २२ ।

In the above Slokas *Govindanātha Muni* is stated to be the preceptor of *Saṅkara*, the former being himself the pupil of *Goudapada*, who in his turn was a pupil of *Sukadeva*, son of *Vyāsa*, the well-known compiler of the Vedas. The *Govindanātha* of the text has been confounded by the commentator, *Dhanapati Sūri* with the Buddhist *Govinda*. It is scarcely necessary to take serious notice of the chronological perspective of the author of the *Saṅkaradigvijaya*.

**The Mechanical, Physical and
Chemical Theories of the
Ancient Hindus.**

(By Principal B. N. Seal.)

I propose in this paper to give a synoptic view of the mechanical, physical and chemical theories of the ancient Hindus. A chronological survey, even if the materials for it were available, would be here of little account. The origins of Hindu natural philosophy in the speculations of the Bráhmaṇas and the Upanishads, or in the mythology of the Purāṇas, however interesting from the standpoint of '*cultur-geschichte*,' do not come within the scope of the present exposition, which relates to the result of systematic thought as directed to the phenomena and processes of Nature. I have therefore confined myself to an account of natural philosophy as expounded in the principal systems of Hindu thought. The Sāṅkhya-Pātañjala system accounts for the Universe on principles of cosmic evolution, the Vaiśeṣhika-Nyāya lays down the methodology of science, and elaborates the concepts of mechanics, physics and chemistry. The Vedānta, the Pūrva-Mīmāṃsā, and in a less degree, the Bauddha, the Jaina, and the Chārvāka systems, make incidental contributions on points of special interest, but their main value in this regard is critical and negative. The principal authorities

followed in this account, —the Vyāsa Bhāshya on Patañjali's sūtras, the Samhitā of Charaka, the Bhāshya of Prasastapāda, the Vārttika of Uddyotakara, and the Vrihat Samhitā of Varāhamihira,—all centre round the Hindu Renaissance, the beginnings of the anti-Buddhist reaction, in the fourth, fifth and sixth centuries of the Christian era. Whenever I have made use of later authors, *e. g.* Kumārila, Saṅkara, Śrīdhara, Vāchaspati, Udayana, Bhāskara, Jayanta, Varvara, Raghunātha, Vijñānabhikṣu &c.. I have taken care to see (except where the opposite is expressly mentioned) that no idea is surreptitiously introduced which is not explicitly contained in the earlier authors.

The Sāṅkhya-Pātañjala System.—This system possesses a unique interest in the history of thought as embodying the earliest clear and comprehensive account of the process of cosmic evolution, viewed not as a mere metaphysical speculation but as a scientific principle based on the conservation, the transformation, and the dissipation of Energy.

Prakṛiti—the ultimate ground:—The manifested world is traced in the Sāṅkhya to an unmanifested ground, Prakṛiti, which is conceived as formless and undifferentiated, limitless and ubiquitous, indestructible and undecaying, ungrounded and uncontrolled, without beginning and without end. But the unity of Prakṛiti is a mere abstraction; it is in reality an undifferentiated

manifold, an indeterminate infinite continuum of infinitesimal Reals. These Reals, termed *Gunas*, may by another abstraction be classed under three heads, (1) *Sattva*, the Essence which manifests itself in a phenomenon, and which is characterised by this tendency to manifestation, the Essence, in other words, which serves as the medium for the reflection of Intelligence, (2) *Rajas*, Energy, that which is efficient in a phenomenon, and is characterised by a tendency to do work, or overcome resistance, and (3) *Tamas*, mass or inertia, which counteracts the tendency of *Rajas* to do work, and of *Sattva* to conscious manifestation.

The ultimate factors of the Universe, then, are (1) Essence, or intelligence-stuff, (2) Energy, and (3) Matter, characterised by mass or inertia.

These *Gunas* are conceived to be Reals, substantive entities,—not however as self-subsistent or independent entities,—(*स्वातन्त्र्य*), but as interdependent moments in every Real or substantive Existence.

Even Energy is substantive in this sense. The infinitesimals of Energy do not possess inertia or gravity, and are not therefore material, but they possess quantum and extensity (*परिमाण—परिवर्धन*).

The very nature of Energy is to do work, to overcome resistance (*व्यवधान—उपपत्ति*), to produce motion. All Energy is therefore ultimately kinetic. Even potential Energy (*अव्यवधान—उपपत्ति*) is only the Energy of motion in imperceptible forms.

The original constituents and their interaction. Every phenomenon, it has been explained, consists of a three-fold *arche*, intelligible Essence, Energy, and Mass. In intimate union these enter into things as essential constitutive factors. The essence of a thing (*sattva*) is that by which it manifests itself to intelligence, and nothing exists without such manifestation in the Universe of Consciousness (*समष्टिबुद्धि*). But the Essence is only one of three moments. It does not possess mass or gravity, it neither offers resistance, nor does work. Next there is the element of Tamas, mass, inertia, matter-stuff, which offers resistance to motion as well as to conscious reflection. (*तमः गुरु वरचक्षम्*).

But the intelligence-stuff and the matter-stuff cannot do any work, and are devoid of productive activity in themselves. All work comes from *Rajas*, the principle of Energy, which overcomes the resistance of matter, and supplies even Intelligence with the Energy which it requires for its own work of conscious regulation and adaptation. (*चन्मान्माभ्याम् चक्षुद्वाराभ्यां स्वकार्योपजनने राजस्याहकारः सहकारी भवति लोकाचार्य-तत्त्वप्रव-चचित्प्रकरणम् ।*)

The *Gunas* are always uniting, separating, uniting again. (*चन्मोन्मनिदुनाः सन्ने, नैवानादिसन्मदोमो निरोमो वा उपपद्यते*). Everything in the world results from their peculiar arrangement and combination. Varying quantities of Essence, Energy and Mass, in varied groupings, act on one another, and

through their mutual interaction and interdependence evolve from the indefinite or qualitatively indeterminate to the definite or qualitatively determinate. (एते गुणाः परस्परोपरकप्रविभागाः रूयोगविभागधर्माश्चः इतरैतरोपाश्रयेण उपार्जितमूर्तयः ।—व्यासभाष्य). But though co-operating to produce the world of effects, these divers moments with divers tendencies never coalesce. In the phenomenal product whatever Energy there is is due to the element of Rajas, and Rajas alone ; all matter, resistance, stability is due to Tamas, and all conscious manifestation to Sattva. (परस्परप्राकाशित्वेऽपि असंभिन्नशक्तिप्रविभागाः—व्यासभाष्य । अन्योऽप्राकाशित्वभावेन उत्पादितेऽपि द्वये प्रकाशगुणः सत्त्वस्त्वेव क्रियागुणः रजस एव स्थितिगुणकामस एव—विज्ञानमिदं योगवार्तिकं on व्यासभाष्य, *ibid*—नेह शक्तयः सकोट्यन्ते—वाचस्पतिमिश्र तत्त्ववैशारदी on व्यासभाष्य *ibid*)

The nature of the interaction is peculiar. In order that there may be evolution with transformation of Energy, there must be a disturbance of equilibrium, a preponderance of either Energy or Mass-resistance, or Essence over the other moments. The particular Guna which happens to be predominant in any phenomenon, becomes manifest in that phenomenon, and the others become latent, though their presence is inferred by their effect. For example, in any material system at rest, the Mass is patent, the Energy latent, and the conscious manifestation sub-latent. In a moving body, the Rajas, Energy, is predominant (kinetic), while the Mass or rather the Resistance

it offers is overcome. In the volitional consciousness accompanied with movement, the transformation of Energy (or work done by Rajas) goes hand in hand with the predominance of the conscious manifestation, while the matter-stuff or Mass, though latent, is to be inferred from the resistance overcome. (प्रधानवेलायाम् अवद्विंदवनिधाना बुद्धत्वेऽपि च व्यापारजातेषु प्रधानानर्गोतावुजिताभिताः—आसमास)

The starting point. The starting point in the cosmic history is a condition of equilibrium or equipoise consisting in a uniform diffusion of the Reals. The tendencies to conscious manifestation as well the powers of doing work are exactly counterbalanced by the resistances of the inertia or Mass. The process of cosmic evolution (परिचय) is under arrest. (उत्तरजलनसं साम्बावस्था प्रकृतिः—Pravachana-Sūtra 61, Chap. I. साम्बावस्था चक्षुनानतिरिक्तावस्था चक्षुनाधिकभावेन च संवृतावस्था चक्षुष्यावस्था इति निष्कर्षः—विज्ञानमिश्र, *ibid*).

Beginning of Evolution. The transcendental (non-mechanical) influence of the Purusha (the Absolute) puts an end to this arrest, and initiates the process of creation. Evolution begins with the disturbance of the original equilibrium. How this is mechanically brought about is not very clear. A modern expounder of the Sāṅkhya supposes that the particles of Sattva, Rajas, and Tamas possess a natural affinity for other particles of their own class, and that when the transcendental influence of the Purusha ends the state of arrest, the

affinity comes into play, breaks up the uniform diffusion, and leads to unequal aggregation, and therefore, to the relative preponderance of one or more of the three Gunas over the others. Thus commences formative combination among the Reals, and consequent productive activity. (रुद्रमन्त्र
आरम्भकसंयोगः श्रुताधिकभावेन चतुर्विधं संयोगविशेषः । Chap. I,
Sútra 66, प्रवचनभाष्य—विज्ञानमिदम् । पृथिवीत्यन्तीनां पृथिवीतिरेव
सत्त्वव्यक्तीनाम् एकजातीयतया एकता । स्वजातीयोपपत्त्यादिना इद्विज्ञानादिकं
च युक्तम् *ibid.*, Sútra 128, Chap. I).

*Formation of wholes or systems—collocation of Reals :—*Creative transformation accompanied with evolution of motion (परिचय) and work done by Energy (क्रिया) cannot take place without a peculiar collocation of the Reals (Gunas). To form wholes or systems (समुदय), it is essential that one Guṇa should for the moment be preponderant, and the others co-operant. And this cannot be without an unequal aggregation which overthrows the original equilibrium (युक्तवैयर्थ्य, श्रुताधिकभाव),—in other words, without unequal forces or stresses coming into play in different parts of the system. (युक्तविरह—वाच्यति ।)
व्यक्तं सन्निरूप्य परिचयवत्.....समुदयः समवायः । स च गुणानां गुणप्रधान-
भावमन्तरैश्च न सम्भवति । न गुणप्रधानभावो वैयर्थ्यं विना । न च वैयर्थ्य-
मुपलक्ष्योपलक्षकभावाद्भवेत् । (वाच्यति, कौमुदी on káriká 16.)

*The Formula of Evolution—*Differentiation in Integration.—Evolution (परिणाम) in its formal aspect is defined as differentiation in the integrated (संवृ-

विशेष). In other words, the process of Evolution consists in the development of the differentiated (वैषम्य) within the undifferentiated (साम्यावस्था), of the determinate (विशेष) within the indeterminate (अविशेष), of the coherent (युतसिद्ध) within the incoherent (अयुतसिद्ध). The evolutionary series is subject to a definite law which it cannot overstep (परिष्थानकनियम). The order of succession is not from the whole to parts, nor from parts to the whole,—but ever from a relatively less differentiated, less determinate, less coherent whole to a relatively more differentiated, more determinate, more coherent whole. That the process of differentiation evolves out of 'homogeneity separate or unrelated parts, which are then integrated into a whole, and that this whole again breaks up by fresh differentiation into isolated factors for a subsequent reintegration, and so on *ad infinitum*, is a fundamental misconception of the course of material Evolution. That the antithesis stands over against the thesis, and that the synthesis supervenes and imposes unity *ab extra* on these two independent and mutually hostile moments is the same radical misconception as regards the dialectical form of cosmic development. On the Sāṅkhya view, increasing differentiation proceeds *pari passu* with increasing integration within the evolving whole, so that by this two-fold process what was an incoherent indeterminate homogeneous whole

evolves into a coherent determinate heterogeneous whole.

The different stadia in the order of cosmic Evolution are characterised as follows :—

- (1) The inconceivable, the unknowable, the formless, of which no character can be predicated (अलिङ्ग), including Prakriti, or the Reals in a state of equilibrium.
- (2) The knowable, the empirical universe, cosmic matter of Experience, things as matter or stuff of consciousness (लिङ्ग),—comprising Mahat, the intelligible Essence of the cosmos, evolved by differentiation and integration within the formless, characterless, inconceivable Prakriti.
- (3) Individuated but still indeterminate stuff bifurcating into two series—Subject-experience and Object-experience,—comprising on the one hand the indeterminate unity of apperception or the empirical Ego, as the co-ordinating principle of Subject-series (अजिज्ञा), and on the other hand, the indeterminate material potencies, the subtle vehicles of potential Energy (तन्मात्र, सूक्ष्म), the ultimate subtle constituents of the Object-series (the material world). The previous stadium, the cosmic matter of Experience (लिङ्ग, अहम्) evolves within itself,

by differentiation and integration, an individuated but still indeterminate stuff in two co-ordinated series, Subject and Object.

- (4) Determinate stuff (विशेष) evolved within the indeterminate by further differentiation and integration, *viz.*, in the series of Subject-experience, sensory and motor stuff; and in the Object series, a corresponding atomic matter-stuff actualising the material potencies in the form of specific sensible Energies. The latter includes the different classes of Paramāṇus, the different kinds of atomic constituents of different kinds of gross matter (सूक्ष्मभूत).
- (5) Coherent and integrated matter-stuff, individual substances, characterised by generic and specific properties, which however are not rigidly fixed, but fluent being subject to a three-fold change and constantly evolving, (चतुर्दशविधावयवमिहातुल्यतः समृद्धः द्रव्यमिति पतञ्जलिः—व्यासभाष्य, Sūtra 44, Chap. III. सामान्यविशेषसमुदायी द्रव्यं—व्यासभाष्य, *ibid.* सामान्यविशेषाभ्यामवयवी धर्मी, *ibid.* धर्मिकी धर्मसमवायव्यवस्थापरिचालः).
- (6) And so the cosmic series moves on in ascending stages of unstable equilibrium (विसङ्गमपरिचाल) until the reverse course of equilibration and dissipation of Energy

(सहस्रपरिचय and साक्षात्कार) which even now constantly accompanies the evolution and transformation of Energy, completes the disintegration of the universe into its original unmanifested ground, the unknowable Prakṛiti.

The order of Cosmic Evolution according to the व्यासभाष्य (Sūtra 19, Pāda II) is shown below, in a tabular form :—

Prakṛiti, the unmanifested unknowable ground
(गूढमव्यक्तमसिद्धं)

Cosmic matter of experience (महत्, सिद्धं)

Subject series (अविज्ञेय)	Object series (अविज्ञेय)
Individuated indeterminate mind-stuff (unity of apperception empirical Ego, अजिज्ञा)	Individuated but indeterminate matter-stuff (subtile material potencies, तन्मात्र)

Determinate mind-stuff (विज्ञेय) sensory and motor psychoses, etc. (ज्ञानेन्द्रिय, कर्मेन्द्रिय and मनः)	Determinate matter-stuff (विज्ञेय) atomic and mole- cular constituents of gross matter (परमाणु—सूक्ष्मवस्तु)
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Coherent and integrated
matter-stuff (अयुतसिद्धावयवः
समूहः सङ्घातः द्रव्यं)

Individual substances,
with generic and specific
characters subject to con-
stant change or evolution
e.g. inorganic objects
composed of atoms or
molecules (परमाणु), vege-
table organisms (वृक्ष),
animal organisms (शरीर)
(अयुतसिद्धावयवः सङ्घातः शरीरं
वृक्षः परमाणुरिति—व्यासभाष्य,
Sútra 44, Páda III).

तत्र तत् संसृष्टं विविच्यते क्रमान्तरितेः, तथा षड्विंशतिः सिद्धमात्रे
संसृष्टा विविच्यन्ते, परिष्कारक्रमनियमात्, तथा तेषु अविशिष्टेषु मूर्तेन्द्रियाणि
संसृष्टानि विविच्यन्ते, न विशिष्टेभ्यः परं तत्त्वान्तरमस्ति तेषाम् धर्मलक्षणा-
वस्थापरिष्कारमा व्याख्यायिष्यन्ते (व्यासभाष्य, Sútra 19, Páda II).

N.B.—The usual order given in the Sāṅkhya
compendiums is as follows :—*Prakṛiti*, *Mahat*,
Ahaṅkāra,—and then the bifurcation, *viz.*, 11 organs
sensory, motor and common sensori-motor from *Rājasic*
Ahaṅkāra, and *Tanmātras* from *Tāmasic Ahaṅkāra*,
—and finally the *Paramānus* of the *Sthūla-Bhūtas*.

The conservation of Energy (and of Mass)—the
transformation of Energy :—

The *Gunas* (Reals), though assuming an infinite
diversity of forms and powers, can neither be created

nor destroyed. The totality of the Mass (Tamas), as well as of Energy (Rajas) remains constant, if we take account both of the manifested and the unmanifested, the actual and the potential. But the individual products of the evolutionary process, the concrete phenomenal modes resulting from the combined action of the original Mass, Energy and Essence, are subject to addition and subtraction, growth and decay, which are only due to changes of collocation, and consequent changes of state from the potential to the actual, (in other words, from the future to the present and from the present to the past, in a time series)—changes, which are illusorily ascribed to the Reals themselves. The different collocations of Mass and Energy give birth to the divers powers of things, the various forms of Energy which may be classed as like and unlike ; indeed the course of Evolution from the Reals conforms to a fixed law, not only as regards the order of succession, but also as regards the appearance (and mutual relations) of like and unlike Energies. And this transformation is constantly going on,—the course of Evolution is not arrested for a moment.

गुणास्तु सर्ववर्थाऽनुपातिनः न प्रत्यक्षमयन्ते नीपजायन्ते व्यक्तिभिरेव
चतीताऽनागतव्ययागमवतीभिः गुणान्वयिनीभिः उपजनापायवर्थाका इव
प्रत्यक्षमायन्ते (व्यासभाष्य, Sūtra 19, Pāda II). परिणामिनित्यता
गुणानाम् । सर्वमिदं गुणानां सन्निवेशविशेषमात्रम् (*ibid*, Sūtra
13, Pāda IV). एते गुणाः तुल्यजातीयानुल्लजातीयव्यक्तिभेदानुपातिनः
(*ibid*, Sūtra 19, Pāda II). परिणामजननियमात् (व्यासभाष्य,

Sútra 19, Páda II). कर्मानाम् परिणामानाम् हेतुः । (*Patañjali*
Sútra 15, Páda III). प्रकृतिः परिवर्तनशीला अचलमयपरिचय
भावति इति ।

The doctrine of Causation, a corollary from the conservation and transformation of Energy :—the principle of collocation—the storing-up and the liberation of Energy :—

The Sāṅkhya view of causation follows at once as a corollary from this doctrine of the conservation and transformation of Energy. As the total Energy remains the same, while the world is constantly evolving, cause and effect are only more or less evolved forms of the same ultimate Energy. The sum of effects exists in the sum of causes in a potential (or un-evolved) form. The grouping or collocation alone changes, and this brings on the manifestation of the latent powers of the Gunas but without creation of anything new. What is called the (material) cause or sum of material causes is only the power which is efficient in the production or rather the vehicle of the power. This power is the unmanifested (or potential) form of the Energy set free (उद्भूतवर्ति) in the effect. But the concomitant conditions are necessary to call forth the so-called material cause into activity. When the favourable combination or co-operation of concomitants is wanting, there is no manifestation of the effect. The question is—what is the aid which the concomitant conditions render to the deter-

mination (and production) of the effect existing in potency in its material cause ? First there is the merely mechanical view as illustrated by some commonplace examples, *e.g.*, the manifestation of the figure of the statue in the marble block by the causal efficiency of the sculptor's art, or of the oil in the sesamum by pressing, or of the grain of rice out of the paddy by the process of husking. In these cases the manifestation of an effect is only its passage from potentiality to actuality, a stadium in the process of evolution from possible (future) existence to actual (present) existence ; and the concomitant condition (सहकारिशक्ति) or efficient cause (निमित्तकारण), the sculptor's chiselling, the pressing, the husking, is a sort of mechanical or instrumental help to this passage or transition. कार्यशक्तिमत्त्वेनैव उपादान-कारणत्वम् । सा शक्तिः कार्यस्य अनागतावस्था एव । स एव विशेषः (उत्पत्तेः प्राक् कारणे विशेषः) अस्माभिः कार्यस्य अनागतावस्था इत्युच्यते (विज्ञानभिन्नु-प्रवचनभाष्य, Sūtra 115, Chap. I). अभिव्यक्तिः वर्तमानावस्था । कारणव्यापारोऽपि कार्यस्य वर्तमानस्यैव परिणाममेव जनयति । यथा प्रिणामस्य प्रतिमायाः खेत्तिक-व्यापारश्च अभिव्यक्तिमात्रं तिष्ठत्यतस्तस्य च निष्पीडनेन आगस्त्यतस्तस्य च अवघातेन (विज्ञानभिन्नु-प्रवचनभाष्य, Sūtra 129, Chap. I).

These mechanical exmples of the Kapila-Sāṅkhya have the merit of simplicity, but the Patañjali-Sāṅkhya brushes them aside, and explains causation on the basis of the conservation and transformation of Energy, advancing it as the liberation of potential Energy existing

stored up in a *Guṇa* collocation, (the sum of material causes) the liberation following on the action of the proximate efficient cause, or concomitant condition (निमित्तकारण).

The causal operation of concomitant conditions (efficient causes) lies only in this that they supply a physical stimulus which liberates the potential Energy stored-up in a given collocation. Everything in the phenomenal world is but a special collocation of the ultimate Reals (Energy, Mass and Essence). The sum of (material) causes potentially contains the Energy manifested in the sum of effects; and in the passage from potency to actualisation, the effectuating condition (the concomitant cause) when it is itself accomplished, is only a step in the evolutionary series, which adds a specific stimulus, and renders determinate that which was previously indeterminate. When the effectuating condition is added to the sum of material conditions, in a given collocation, all that happens is that a stimulus is imparted, which removes the arrest, disturbs the relatively stable equilibrium, and brings on a liberation of Energy (उद्भूतशक्तिवृद्धि) together with a fresh collocation (वृद्धशक्तिवैयर्थ्यनिवृत्ति). सर्व्वमिदं गुणानां सन्निवेशविशेषमात्रम् इति परमार्थतो गुणात्मानः (व्यासभाष्य, Sūtra 13, Pāda IV). सततं फलस्य निमित्तं वर्तमानोक्तस्य समर्थे न अपूर्व्वोपजनने । सिद्धं निमित्तं निमित्तकारणं विद्येयानुसङ्गं कुर्वते । नापूर्व्वमुत्पादयति (व्यासभाष्य, Sūtra 12, Pāda IV).

Describing the production of bodies ('organic vehicles') for individual souls, out of matter of Prakṛiti, under the influence of their merit and demerit, as concomitant conditions, Patañjali points out that non-material concomitants like merit and demerit do not supply any moving force or Energy to the sum of material conditions, but only remove the arrest (the state of relatively stable equilibrium) in a given collocation, even as the owner of a field removes the barrier in flooding his field from a reservoir of water. This description is intended to represent the super-physical influence of non-material concomitants (or causes) like volition, merit and demerit, etc., but the causal operation of a material concomitant condition is essentially the same;—there is the same reservoir of stored-up Energy in a given collocation,—the same condition of arrest or relatively stable equilibrium,—the same liberation of the stored-up potential Energy which flows along the line of least resistance;—the only difference being that in the case of material concomitants the stimulus which removes the arrest is physical, instead of being transcendental as in the case of non-material causes like will, merit and demerit, etc.

The Vyāsa-bhāṣya helps us to a clear mental representation of the details of this process, being perhaps the finest example before Newton of the exercise of a Scientific Imagination, and as memor-

able as any in the whole history of thought containing as it does the theory of potentials as in a nutshell :—As the owner of many fields can irrigate, from a field which is already flooded, others of the same or a lower level, without forcing the waters thereto with his hands, and merely by making an opening in the barrier or dyke, on which the waters rush in by their own force ;—or further, as the same person cannot force these waters, or the earthy matters held in solution therein, into the roots of the rice plants, but only removes the obstructive grasses and weeds, on which the fluids of their own power enter the roots ;—such is the action of an effectuating condition (निमित्त) added to a sum of material causes or conditions.

निमित्तम् अप्रयोजकं प्रवृत्तीनां वरणभेदस्तु ततः चेन्निकवत् (*Patañjali Sūtra 3, Páda IV*). न हि धर्मादि निमित्तं यथा चेन्निकः केदारात् अपां पूरणात् केदारं पित्रावयिषुः समं निम्नं वा निम्नतरं वा नापः पात्रिनापकर्षति आवरणं तु बासां भिन्नं तस्मिन् निम्ने स्वयमेवापः केदारान्तरम् आग्रावयति ।

Chain of Causation—fixed order.—The order of Evolution with the transformation of the Energies follows a definite law. The unalterable chain of causes and effects in the phenomenal world illustrates this fixed order. But though the cosmic order is one and fixed, it comprehends divers series arising from different combinations of the original Gunas, which constitute subordinate or particular laws of cause and effect (कामाच्चत्वं परिणामाच्चत्वं हेतुः, *Patañjali Sūtra 15, Páda III*).

What we call the qualities of things are only modes of Energy acting in those collocations. योग्यतावच्छेदा चर्चः शक्तिरिव धर्मः—स च फलप्रसवभेदागुमितसङ्घातः (व्यासभाष्य, Sūtra 14, Páda III). ते खल्वनी धर्मो वर्तमाना व्याप्तात्मानः, अतीताऽनागताः सूक्ष्मात्मानः सर्वमिदं गुणानां सद्भिर्विशमाव्रमिति परमार्थतो गुणात्मानः (व्यासभाष्य, Sūtra 3, Páda IV). And these various Energies are sometimes actual (kinetic), sometimes potential, rising to actuality, and sometimes sublatent, subsiding from actuality into sublatency. In fact, the original Energy is one and ubiquitous, and everything therefore exists in everything else, *potentialiter* (सर्वं सर्वोत्पत्तिरिति), without prejudice to the generic and specific differences of things (जात्यनुच्छेदेन सर्वं सर्वोत्पत्तिरिति). Inorganic matter, vegetable organisms, and animal organisms are essentially and ultimately one (जलभूयोः पारिणामिकं रसादिवैचक्यं स्यादरेषु दृष्टं तथा स्यादराणां जलमेषु जलमानां स्यादरेषु) so far as Mass and Energy are concerned, but the varied forms of Energy and the generic and specific qualities (or properties) of things, which are but modes of Energy, follow a definite unalterable law in the order of their appearance and succession, under conditions of space, time, mode and causality, and hence all effects do not manifest themselves at once देशकालाकारनिमित्तापवन्मात् न खलु समानकालम् आत्मनामभिव्यक्तिः (*ibid*, Sūtra 14, Páda III). यो यस्य धर्मस्य समनन्तरी धर्मः स तस्य क्रमः। पिबुः प्रच्यवते घट उपजायते इति धर्मोपरिणामक्रमः। लक्षणापरिणामक्रमः घटस्य अनागतभावात् वर्तमानभावक्रमः, तथा पिबुस्य वर्तमानभावात् अतीतभावक्रमः (व्यासभाष्य, Sūtra 15, Páda III).

(and therefore of time, काल). If this is held to be an irreducible absolute unit, it will follow that what we represent as the time-continuum is really discrete. Time is of one dimension. Two moments cannot co-exist. Neither does any series of moments exist in reality: Order in Time is nothing but the relation of antecedence and sequence, between the moment that is, and the moment that went just before. But only one moment, the present, exists. The future and the past have no meaning apart from potential and sublatent phenomena. One kind of transformation, to which a thing is subject, is that it changes from the potential to the actual, and from the actual to the sublatent. This may be called the change of mark (लक्षणापरिवर्तन) as opposed to change of quality (धर्मपरिवर्तन), and the change due to duration or lapse of time (अवस्थापरिवर्तन). The present is the mark of actuality,—the future, the mark of potentiality,—and the past, of sublatency,—in a phenomenon. Only one single moment is actual, and the whole Universe evolves in that one single moment. The rest is but potential or sublatent.

अणुतत्त्वमयोर्नास्ति वस्तुसमाहार इति बुद्धिसमाहारः सुहृत्पांडीरावादयः । स खल्वयं कालः वस्तुस्थौ बुद्धिनिर्माणः शब्दज्ञानानुपाती लौकिकानां व्युत्थितदर्शनानां वस्तुस्वरूप इव अवभासते । अणुस्तु वस्तुपतितक्रमःपल्लवी । क्रमश्चाप्यनन्तर्याम्ना । तं कालविदः काल इति भावयते योगिनः । न च ह्यौ अणौ सङ्ग भवतः, क्रमश्च न द्वयोः सङ्गमुदीरसम्भवात् पूर्वकादुत्तरभाविनी यदानन्तर्यं चावस्थ स क्रमः । तस्मात् वर्तमान एवेकः अणुः न पूर्वोत्तरावस्थाः

सन्तीति तन्मात्रास्ति तत्समाहारः । यी तु भूतभाविनः चक्षुः ते परिचयानाम्बिता
व्याख्येयाः । तेनेकेन चक्षेन कृतसो र्जाकः परिचयानसमुभवति, तत्तच्छाकृदाः
खल्वनी धर्माः । यथाऽपकर्षपर्यन्तं द्रव्यं परमाणुः एव परमाणुपर्यन्तः
काष्ठः चक्षुः । यावता वा समयेन चलितः परमाणुः पूर्वदेशं गच्छात्
उत्तरदेशम् उपसम्पद्येत स काष्ठः चक्षुः, तत्प्रवाहाविच्छेदस्तु क्रमः । (व्यासभाष्य
Sutra 52, Pada III.)

Vijñāna-bhikshu points out that this does not amount to a denial of Time. It means that time has no real (or objective) existence apart from the 'moment'. But the latter is real, being identical with the unit of change in phenomena (गुणपरिचयानस्य चक्षुः-वचनात्). But even this is real only for our empirical (relative) consciousness (व्युत्थितदर्शन), which intuits the relation of antecedence and sequence into the evolving Reals (Gunas), in the stage of 'empirical intuition' (सविचारा निर्विकल्पप्रज्ञा). The 'intellectual intuition' (निर्विचारा निर्विकल्पप्रज्ञा) on the other hand, apprehends the Reals as they are, without the empirical imported relations of Space, Time and Causality.

Space as extension and Space as position :—

Space must be distinguished as Desa (locus, or rather extension) and Dik (relative position). Space (Dik) as the totality of position, or as an order of co-existent points, is wholly relative to the Understanding, like order in time, being constructed on the basis of relations of position intuited by our empirical (or relative) consciousness. But there is this difference between Space-order and Time-order :—there is no unit of Space as position (Dik),

though we may conceive a unit of Time, *viz.*, the moment (कण) regarded as the unit of change in the phenomenal or causal series (परमावृत्तिया or गुणपरिणामस्य चक्षुष्यवचनात्—योगवार्तिक, Sutra 51, Pada III). Spatial position (Dik) results only from the different relations in which the all-pervasive A'kāśa stands to the various finite (or bounded) objects. On the other hand, Space as extension or locus of a finite body, Desa (देशः स्थित्याधारः), has an ultimate unit, being analysable into the infinitesimal extensive quantity inherent in the Reals (Gunas) of Prakṛiti. (गुणप्रकृतेरक्षपरिणामः—योगवार्तिक । एतेन निम्ना दिगपि चप्रामाण्यको व्याख्याता, सामान्यतो दिग्व्यवहाराभावात् । पूर्व्यादिव्यवहारस्य दिगुपाधिभिरेव सम्भवात् सामान्यतः कालदिग्व्यवहारसत्त्वेऽपि आकाशादेव तदुपपत्तेश्च । कालाच्च दिग्ध्ययं विशेषः यत् कालः अक्षरूप इत्यते, दिक् तु सर्वध्येव नैष्यते ।

The Casual series.—The relation of Cause and Effect has been already explained. It only remains to add that the category of causality is mediated through the *schema* of order in Time. The Empirical Intuition first superimposes relations of antecedence and sequence on changing phenomena (the evolving Gunas or Reals), and the Understanding out of these relations creates order in Time. The Empirical Intuition then intuits the phenomenal series of transformations of Energy in this Time-order and in so doing, imports the relation of cause and effect into the course of Nature. (कार्यकारणभावादीनां चक्षुषटित्वात्—योगवार्तिक, Sutra 51, Pada III).

The dissipation of Energy (and of Mass)—their dissolution into the formless *Prakṛiti*:—Cosmic Evolution (परिणाम) is a two-fold process, creative as well as destructive, dissimilative as well as assimilative, katabolic as well as anabolic (अनुजीमसर्ग and विजीमसर्ग, विसृष्ट्यपरिणाम and सृष्ट्यपरिणाम). In one aspect, there is the aggregation (unequal aggregation) of Mass and Energy, with consequent transformation of Energy, resulting in the creation of inorganic as well as organic matter, and the genesis of worlds. The successive steps of this process may be described as (1) unequal aggregation with storing-up of Energy in a certain collocation, under a state of arrest (i. e., in a state of relatively stable equilibrium), (2) a stimulus removing the arrest, and disturbing the equilibrium, and (3) liberation of the Energy, moving on to a fresh collocation, fresh aggregation, arrest and equilibrium. The process of the world thus moves on from equilibrium to equilibrium, and the result of that process is the development of a coherent determinate heterogeneous whole (लिङ्ग अविशेष विशेष, अयुतसिद्धावयवसमूह, युतसिद्धावयवसमूह) in what is essentially an incoherent indeterminate homogeneous whole (अलिङ्ग).

But there is a second aspect of this evolutionary process. Unequal aggregations are unstable, there is a constant tendency in things to go back to the original stable equilibrium,

the state of uniform equal diffusion of Reals. This process is called the resolution of like to like (सहस्रपरिचय), consisting in assimilation and dissipation, and being the exact opposite of the process of "differentiation in the integrated" which has evolved the Cosmos. The collocations of Mass, Energy and Essence are always breaking up, and the Energy as well as the Mass, however slowly, however imperceptibly, are being dissipated, *i. e.*, dissolved into the original formless Prakṛiti, a state of permanent equilibrium and arrest, from which there is and can be no return, except under the transcendental influence of the Absolute at the commencement of a new creative cycle. Not that there is a destruction of the Mass or Energy, but a dissipation or dissolution into a condition of equal uniform diffusion from which there is no return. This is not the phenomenon of kinetic Energy disappearing and becoming potential or sublatent, for in such cases there is restitution or reconversion by natural means. When this reverse current of assimilation (and dissipation) prevails over the current of dissimulation (and integration), the Universe will disintegrate more and more, until it disappears in the formless Prakṛiti, its unknowable source and ground (तत्त्वज्ञान and ब्रह्म).

The Evolution of matter (तात्त्विक चक्र) :—

The ultimate constitution of Matter is a question of the profoundest interest in the Sāṅkhya-Pātañ-

jala system. Three stages clearly stand out in the genesis of Matter :—(1) the original infinitesimal units of Mass or inertia, absolutely homogeneous and ubiquitous, on which Energy does work, when the original equilibrium comes to an end (भूतादि—तानसादृशम्), (2) The infra-atomic unit potentials, charged with different kinds of Energy, which result from the action of Energy on the original units of Mass, (तन्मात्र), and (3) the five different classes of atoms, the minutest divisions of which gross matter is capable, but which are themselves complex Tanmátric systems (स्थूलभूतपरमाणु).

The first stadium Bhútádi is absolutely homogeneous and absolutely inert, being devoid of all physical and chemical characters (रूपादिभिरसंयुतं) except quantum or mass (परिच्छिन्नत्व. परिमाण); and this admits neither of addition nor of subtraction, can neither be created nor destroyed. The second stadium Tanmátra represents subtile matter, vibratory, impingent, radiant, etc., instinct with potential energy. These potentials arise from the unequal aggregation of the original mass-units in different proportions and collocations with an unequal distribution of the original Energy (Rajas). (तन्मात्ररूपादेः किं कारणम् इति चेत् स्वकारणद्रव्याणां न्यूनाधिकभावेन चक्षुर्ग्राह्यं प्रति संयोगविशेष एव—स्वजातीयोपपत्त्यादिना हृदिकासादिकं च युक्तं.) The Tanmátras possess something more than quantum of Mass and Energy. They possess physical characters, some of them penetrability

(अवकाशदान), others powers of impact or pressure, others radiant heat, others again capability of viscous and cohesive attraction. In intimate relation to these physical characters they also possess the potentials of the energies represented by sound, touch, colour, taste and smell, but being subtile matter they are devoid of the peculiar forms (विशेष) which these potentials assume in particles of gross matter like the atoms and their aggregates. In other words, the potentials lodged in subtile matter must undergo peculiar transformations by new groupings or collocations to be classed among sensory stimuli,—gross matter being supposed to be matter endued with properties of the class of sensory stimuli, though in the minutest particles thereof the sensory stimuli may be infra-sensible (अतीन्द्रिय but not अनुद्भूत). (तर्कालङ्कारे तन्मात्राः ते च अविशेषितः । ते च पदार्थाः ज्ञानघोरमूढाख्येः स्थूलगत-ब्रह्मादिविशेषेः शून्या एककपत्वात् । तथा च ज्ञानादिविशेषशून्यब्रह्मादि-मत्त्वमेव भूतानां ब्रह्मादितन्मात्रत्वम् ।)

The Tanmātras, then, are infra atomic particles charged with specific potential energies,—first, the potential of the sound stimulus is lodged in one class of particles, Tanmātras which possess the physical energy of vibration (परिचन्द) and serve to form the radicle of the ether atom (आकाशपरमाणु), then the potential of the tactile stimulus is lodged in another class of Tanmātras, particles which possess the physical

energy of impact or mechanical pressure in addition to that of vibration and serve to form the radicle of the gas atom (Váyu Paramánu) ;—next, the potential of the colour stimulus is lodged in a third class of Tanmátras, particles which are charged with the energy of radiant heat and light in addition to those of impact and vibration and serve to form the nucleus of the light and heat corpuscle ; then the potential of the taste-stimulus is lodged in other Tanmátras, particles which possess the energy of viscous attraction, in addition to those of heat, impact and vibration, and which afterwards develop into the atom of water, and lastly, the potential of the smell-stimulus is lodged in a further class of Tamátras, particles which are charged with the energy of cohesive attraction, in addition to those of viscous attraction, heat, impact and vibration and which serve to form the radicle of the earth-atom.

वङ्गविशेषाः तद्यथा शब्दतन्मात्रं स्पर्शतन्मात्रं रूपतन्मात्रं रसतन्मात्रं
गन्धतन्मात्रञ्च इत्येकैरिन्द्रियचतुष्टयसङ्गच्छाः शब्दादयः पञ्चाविशेषाः । व्यासभाष्य,
Sutra 19 Pada II अङ्गकारात् शब्दतन्मात्रं तत्तथाङ्गकारसङ्गतात्
शब्दतन्मात्रात् शब्दस्पर्शगुणं स्पर्शतन्मात्रम् । एवंक्रमेण एकेकगुणशङ्का
तन्मात्राणि सत्यस्य (प्रवचनभाष्य—Sutra 62, Chap. I).

शब्दादीनां भूतिसमानजातीयानां एकः परिव्रानः पृथिवीपरमाणुः
तन्मात्रावयवः । भूतान्तरि अपि केहीचाप्रचानित्वाऽवकाशदानानि उपादाय
सामान्यम् एकविचारारम्भः समाधेयः । (व्यासभाष्य, Sutra 14.
Pada IV.) तद्यथा । गन्धतन्मात्रं वर्जयित्वा चतुस्तन्मात्राणां केहीजातीयानां

must not be confounded with vacuum, which is merely negative (आवकाशभाव—un-occupiedness), though it must be conceived as all pervasive, occupying the same space as the various forms of gross matter (समानदेशकम्—अवकाशरूपम् आकाश—योगवार्तिक), and therefore devoid of the property of impenetrability (सूक्तान्तरासमानदेशत्वं—योगवार्तिक) which characterises atomic matter. But when the original equilibrium (साम्यावस्था) comes to an end, unequal aggregations form collocations in different groups and proportions of the three Gunas (गुणाधिकभावेन अन्वीर्यं संयोगविशेषः संवृत्तम्—विज्ञानमिच्छु, प्रवचनभाष्य and योगवार्तिक).

The transformation of Energy now begins,—working on a collocation of mass (with Essence) (गुणान्तरोप-सम्बद्धं संवृत्तम्:—विज्ञानमिच्छु, योगवार्तिक); it first gives rise to the sound potential (शब्दजननयोग्याद्यैरेव परिचलति—विज्ञानमिच्छु) and the atomic A'kāśa (proto-atom, protyle) is but an integration of the original unit of mass charged with this vibration potential. This vibratory (or rather rotary) ether-atom (आकाशाणु) is integrated, limited (परिच्छिन्न) and as such cannot occupy the same space with other (subsequently integratad) atoms. But this proto-atomic integration of A'kāśa (काव्योकाश) is formed everywhere, and itself residing in the ubiquitous non-atomic A kāśa (कारणाकाश—अवकाशरूपमाकाश) forms the universal medium in which air or gas atoms, light and heat corpuscles, and other atoms move and float about. (वायोरावरणं । यदि हि अवकाशरूपम् 'आकाशं

न स्यात् तदा मूर्तद्रव्येषु व्याख्यादिषु अन्तर्लोक्यादिवेशी न स्यात्—
विज्ञानभिच्च, योगवार्त्तिक Sutra 40, Pada III. आकाशं हि
कार्यकारणरूपेण विविधम्। एत कारणाकाशं तन्मीगुणविशेषतयेव
व्यवह्रियते। तदानीम् आकाशताव्यञ्जकशब्दादिगुणविशेषाभावात्। तच्च
कारणाकाशं गुणान्तरसमूहं सदर्शयतः आदौ शब्दजननमीत्याद्यर्थरूपेण परिणमते
ततश्च अणुसङ्घातेन पृथिवीवदेव सङ्घाभूताकाशम् अणुकारापेक्षया परिणमन्
वाथोदावरणम् उत्पद्यते (विज्ञानभिच्च, योगवार्त्तिक, Sutra 41, Pada III).

*The genesis of the infra-atomic unit-potentials
(Tanmātras) and of the atoms.*

The subject of the genesis and the structure of the Tanmātras and the Paramānus was a fascinating one to these ancient thinkers. and a wide divergence of views prevailed. I will here notice several typical views :—those of the Vishnu Purāna, Parāsara, Patañjali and a certain School of Vedantists reported in the तत्त्वनिर्णय.

1. A famous passage in the Vishnu Purāna explains the genesis and the structure of the Tanmātras and of the Bhútas (Paramānus) in the following manner :—

The first Tanmātra originated from the rudiment-matter (Bhútādi), the individuated but still indeterminate potential-less Mass in Prakṛiti under the action of Energy (उपपन्नतः परिणमनशक्तिः—प्रवचनभाष्य, Sutra 66, Ch. I.) by a process of disintegration and emanation (विभक्त्यर्थः—विष्णुपुराण—एकविकारारम्भः—व्यासभाष्य, Sutra 14. Pada IV. विकारभावः विकीर्णतासमाप्ती व्यापिता इति

यावत्, योगवाचिक on *Patañjali's* Sutra.—मनीजवित् विकरन्भावः etc.) in the menstruum, or surrounding medium of the unindividuated Cōsmic Mass (Mahat) (महताहतः).

This first subtile matter, the first result of 'Mass disintegration' and Energy-transformation, is charged with the sound-potential, the potential of vibration or oscillation (परिस्पन्द). It is called the sound-potential (शब्दतन्मात्र)

This is typical of the genesis (and structure) of the other Tanmātras (kinds of subtile matter). In each of the remaining cases, an atomic Mass charged with actual specific energies (भूतपरमाणु) disintegrates and emanates, and thus evolves a form of subtile matter (a kind of Tanmātra) under the action of Energy, and always in the same menstruum or surrounding medium,—that of Bhútādi, the super-subtile. Each kind of subtile matter becomes charged with a new potential in addition to the potentials already evolved. The genesis of an atom, Bhúta-Paramānu, is a quite different process. Here the unit potential (Tanmātra) receives an accretion of Mass, and by a sort of condensation and collocation evolves an atom (Bhúta-Paramānu).

The genesis and structure of the Tanmātras and the Bhúta-Paramānus are worked out below :—

1. The super-subtile individuated Mass (rudiment matter (Bhútādi), under the action of the

original Energy (रजः) disintegrates and emanates (विडुहते) in the menstruum or surrounding medium (समारण) of Mahat, cosmic super-subtile Mass, and evolves a form of subtile matter (तन्मात्र), which becomes charged with the sound-potential (vibration-potential, परिचन्द), and is called the unit of sound-potential (शब्दतन्मात्र).

2. This subtile matter, the Mass, charged with sound-potential, receives an accretion of Mass from the rudiment matter (Bhútádi) and by condensation and collocation evolves the A'kása Bhúta, the atomic A'kása, the proto-atom charged with the specific energy of the sound stimulus (actual vibratory motion.) (स एव भूतवृद्धिः शब्द-तन्मात्रात् स्वचित्तौघात् शब्दगुणकम् आकाशं ससर्जम् । तथा च बहुवारशब्दतन्मात्राभ्यां मिलित्वा आकाशं स्रज्यते,—योगवासिक on the Vishnu Purána passage, Sutra 14, Pada IV).
3. This proto-atom, the atomic A'kása, charged with its actual specific energy, again disintegrates and emanates, under the action of the original Energy, and in the menstruum of the rudiment-matter (super-subtile Mass) and thus evolves another kind of subtile matter; (Tanmátra) which becomes charged with the touch-potential (the potential of impact or mechanical pressure

(प्रकाशित, शक्तिशाल) in addition to the sound-potential (vibration-potential—परिचय) and is called the unit of touch-potential (सम्पर्कशक्ति).

4. Next, this subtile matter, the mass charged with touch (and sound) potential, *i.e.*, with the potentials of vibration and impact, receives an accretion of mass again from the rudiment-matter (Bhútádi) and by condensation and collocation, evolves the Váyu Bhúta, a kind of gaseous matter or air of which the atoms are charged with the actual specific energy of the touch stimulus, *i.e.*, with actual energy of impact in addition to the actual energy of vibratory motion.
5. Next, the atom of Váyu, so charged with the actual specific energy of impact and vibration, again disintegrates and emanates, under the action of the original Energy, and in the same menstruum or surrounding medium of the rudiment matter (super-subtile Mass—Bhútádi) and thus evolves another kind of subtile matter (Tanmátrā), which becomes charged with the heat-potential (बीजा—उद्—heat-and-light-potential) in addition to the impact-potential and the vibration-potential, and is called the unit of colour-potential (रूपशक्ति).

6. Now this subtile matter, this radiant matter, charged with light-and-heat-potential, and also with impact and vibration-potential, receives an accretion of Mass again from the rudiment-matter (Bhúti), and by condensation and collocation evolves the Tejas Bhúta, the light-and-heat-corpuscle, which is charged with the specific Energy of the colour-stimulus, i.e., radiates actual heat and light (विद्युत्) in addition to manifesting the energy of impact (impingency) and of vibration (or oscillation).
7. Next, this atom or light-and-heat-corpuscle disintegrates, and emanates as before a form of subtile matter charged with the taste-potential (रसतन्मात्र), in addition to the three potentials already generated, and also with the physical potential of viscous attraction.
8. This subtile matter charged with the taste-potential and with the potential of viscous attraction condenses and collocates as before into the water-atom which manifests the actual specific energies of viscous attraction and the taste-stimulus.
9. The viscous water-atom charged with the actual specific Energy of the taste stimulus disintegrates, and emanates as before a form of subtile matter charged with the

smell-potential in addition to the four potentials already generated and also with the potential of cohesive attraction.

10. This subtle matter charged with the smell-potential and with the potential of cohesive attraction condenses and collocates as before into the earth-atom, which manifests the actual specific Energies of cohesive attraction and the smell-stimulus.

Vijñāna bhikshu in the Yoga-Vártika briefly summarises the Vishnu Purāna process as follows :—

Bhútādi as radicle in conjunction with Mahat produces the sound potential, which as radicle in conjunction with Bhútādi produces A'kāśa, which as radicle in conjunction with Bhútādi produces the touch-potential, which as radicle in conjunction with Bhútādi produces Vāyu, which as radicle in conjunction with Bhútādi produces the colour-potential, which as radicle in conjunction with Bhútādi produces Tejas and so on.

In this brief summary he does not bring out the force of विकृष्णः (the disintegrating process), and the distinction between the genesis of subtle and gross matter (Tanmātra and Bhúta).

यथा प्रथमैव महान्, महता च तथाहतः ।

भूतादिस्तु विकृष्णः सग्रे तन्मात्रिकं ततः ।

सद्यः शब्दतन्मात्रात् आकाशं शब्दलक्षणेन ।

शब्दनामं तदाकाशं भूतादिः स संलाहयौत् ।

आकाशस्य विकृर्वाणः अर्थनामं सद्यः ह ।

नक्षत्रान् चमयत् वायुः तस्य अर्थो युक्तो मतः । (विष्णुपुराण)

11. A famous passage in Parásara takes another view of the genesis and structure of the Tanmātras and the Bhūta-Paramānus. Krishna-pāda, in the तत्त्वमसिब्रह्मण, represents the scheme as follows :—

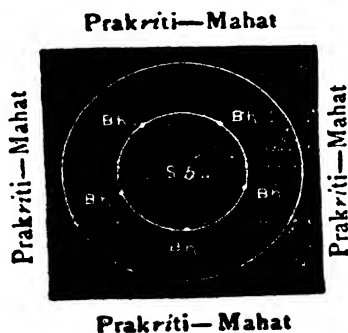
The Tanmātras originate from one another in one linear series, and each Bhūta originates in a separate line from its own Tanmātra .—

भूतादि (Bhūtādi)

शब्दतन्मात्र	Sound-Tanmātra—as a radicle or centre surrounded or encircled by Bhūtādi generates A'kāśa.
स्पर्शतन्मात्र	Touch-Tanmātra—as a radicle or centre encircled by Sound-Tanmātra with A'kāśa-atom as a help generates Vāyu—
रूपतन्मात्र	Colour-Tanmātra—as a radicle or centre encircled by Touch-Tanmātra with Vāyu-atom as a help generates Tejas—
रसतन्मात्र	Taste-Tanmātra—as a radicle or centre encircled by Colour-Tanmātra with Tejas-atom as a help generates Ap—
गन्धतन्मात्र	Smell Tanmātra—as a radicle or centre encircled by Taste-Tanmātra with Ap-atom as a help generates Prithivi.

The genesis of a Bhúta-Paramánu (atom) from the subtile matter of a Tanmátra is not here so simple as in the view of the Vishnu Purána. The latter speaks of condensation and collocation, but in the passage under reference a Tanmátra is supposed to act as a radicle, as the centre of a system, surrounded or encircled by Tanmátras of the immediately higher order in the medium of its own Bhúta.

Thus an atom of A'kása has the following structure :—



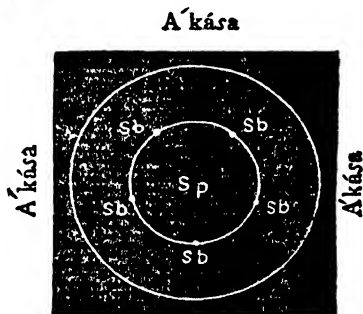
An atom of A'kása

Sb = S'abda-Tanmátra (vibration-potential)

Bh = (Bhútádi)

An atom of Váyu is constituted as follows :—

This takes place within the surrounding medium of A'kása.



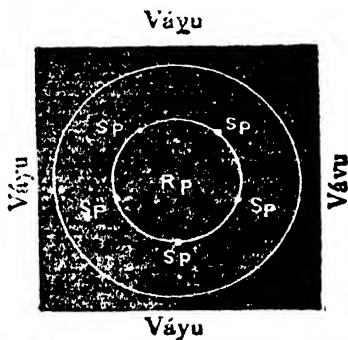
A'kása

An atom of Váyu

Sp = Sparsa-Tanmátra (impact-potential)

Sb = S'abda-Tanmátra (vibration-potential)

An atom of Tejas—heat-and-light corpuscle—
has the following structure :—



An atom of Tejas

Rp = Rúpa-Tanmátra (light-potential)

Sp = Sparsa-Tanmátra (impact-potential)

and so on.

A Chemist will be disposed to push his chemical processes into the region of subtile matter. He may translate चावरण as a menstruum, and सहायक as a catalytic agent. In this case, an atom of Váyu will be considered as generated from the impact-Tanmátra as a radicle, in the menstruum of vibration-Tanmátra, with A'kása-atoms as a catalytic agent.

अथायं क्रमः—भूतादेः शब्दतन्मात्रं जायते, शब्दतन्मात्रं भूतादिराहणीति, तत आकाशं जायते, ततः अस्मात् शब्दतन्मात्रात् स्पर्शतन्मात्रं जायते, स्पर्शतन्मात्रं शब्दतन्मात्रमाहणीति, एवं शब्दतन्मात्राहतात् आकाशसहायकात् स्पर्शतन्मात्रात् वायुर्जायते, ततः अस्मात् स्पर्शतन्मात्रात् रूपतन्मात्रं जायते रूपतन्मात्रं स्पर्शतन्मात्रमाहणीति, एवं स्पर्शतन्मात्राहतात् वायुसहायकात् रूपतन्मात्रात् तेजो जायते—and so on. अयं क्रमः तत्त्वत्रयविवरणे कृष्णपादैरुक्तः। अवरमुनि, तत्त्वत्रयभाष्य (अभिप्रेक्षण).

A slight variation of the above view is ascribed to a certain school of Vedántists in the तत्त्वत्रयभाष्य.

The scheme may be represented as follows :—

A Bhúta-atom is evolved by integration (condensation and collocation, सङ्काशरूप) from the corresponding Tanmátra (subtile matter). This is the same view as that of the Vishnu purána.

The Tanmātras again evolve from one another in a lineal series as in Parāsara's view. But the process of this generation is somewhat more complex. A Tanmātra first disintegrates and emanates in a surrounding medium (a menstruum) of the Tanmātra just preceding it in the order of genesis and with the help of its own Sthūla Bhūta as a sort of catalytic, generates the Tanmātra next in order ; e.g., the infra-atomic impact particles (अर्धतन्मात्र) disintegrate or emanate, in a surrounding 'atmosphere' of the vibratory subtile matter (सूक्ष्मतन्मात्र) and then with the help of their own atomic integration Vāyu, gas, generate the Tanmātra next in order, the subtile matter of radiant light-and-heat (तेजः).

III. Patañjali's view, as expounded in the व्यासभाष्य and योगवासिष्ठ is as follows :—

(a) The order of genesis of various forms of subtile matter (potentials) :—

(1) Bhūtādi, the rudiment-matter, original Mass, acted on by Rajas, Energy, produces the sound-potential (vibration-potential) अनाद्वयान्तरात् स्रष्टव्यस्यैव स्रष्टव्यस्यैव राजसाद्वहः स्रष्टव्यो भवति ।.

(2) This subtile vibration-potential, as a radi-
cle, with accretion of rudiment-matter

(Bhútádi) condensing and collocating, and acted on by Rajas, generates the subtile touch-potential (impact-potential) which is impingent as well as vibratory (oscillating).

- (3) This subtile impact-potential again, as a radicle, with accretion of rudiment-matter (Bhútádi) condensing and collocating, and acted on by Rajas, generates the subtile light-and-heat potential (उपपन्न) which radiates light-and-heat, in addition to being impingent and vibratory.
- (4) Next, the light-and-heat potential, as a radicle, with accretion of rudiment-matter, (Bhútádi) condensing and collocating as before, generates the subtile taste-potential, which is charged with the potential of the taste-energy, and of viscous attraction, in addition to being vibratory, impingent and radiant.
- (5) Lastly, the subtile taste potential as a radicle, with accretion of rudiment-matter as before, condensing and collocating, generates the subtile smell-potential, which is charged with the potential of the smell-energy, and also of cohesive attraction, in addition to being vibratory, impingent and radiant.

The order of genesis of the Bhúta Paramánuś (forms of atomic matter).

The five classes of atoms are generated as follows :—

- (1) The sound-potential, subtile matter, with accretion of rudiment-matter (Bhútádi) generates the A'kása-atom.
- (2) The touch-potentials combine with the vibratory particles (sound-potential) to generate the Váyu-atom.
- (3) The light-and-heat potentials combine with touch-potentials and sound-potentials (*i.e.* with impact particles and vibratory particles) to produce the Tejas-atom.
- (4) The taste-potentials combine with light-and-heat potentials, touch-potentials and sound-potentials (*i.e.* with radiant, impingent and vibratory particles) to generate the Ap-atom and
- (5) The smell-potentials combine with the preceding potentials (*i.e.* with particles of taste-energy and with radiant, impingent and vibratory particles) to generate the earth-atom.

The A'k'śa-atom possesses penetrability, the Váyu-atom impact or mechanical pressure, the Tejas-atom, radiant heat-and light, the Ap-atom, viscous attraction, and the Earth-atom, cohesive attraction.

Vijñāna-bhikṣhu in one passage gives the following scheme of the genesis of the Bhūtas :—

A radicle of sound-potential with rudiment-matter gives A'kāśa-atom (Bhūtādi), a radicle of touch-potential with A'kāśa-atom gives Vāyu-atom, a radicle of light-and-heat potential with Vāyu-atom gives Tejas-atom, a radicle of tastepotential with Tejas-atom gives Ap-atom, and a radicle of smell-potentials with Ap-atom gives Earth atom. On this view, an atom

of A'kāśa = Bh(Sb)

of Vāyu = { Bh(Sb) } (Sp)

of Tejas = { Bh(Sb) } {Sp} Rp

where Bh = भूतादि, Sb = स्पर्शतन्मात्र, Sp = स्पर्शतन्मात्र, Rp = रूपतन्मात्र, and so on.

Bhūtas and Paramānu—Cosmo-genesis and its successive stages.

The 'five Bhūtas' stand for a classification of substances on the basis of their generic properties resulting, as the Sāṅkhyas hold, from the structural type of their constituent atoms—a classification more physical than chemical, or properly speaking chemico-physical, unlike the purely chemical classification of the so-called elements of modern chemistry. A Paramānu, again, is a type of atoms corresponding to each Bhūta class, and indeed one and the same kind of Paramānu may comprehend atoms

of different masses, if only these should agree in their structural type.

Cosmo-genesis—a bird's eye view :—Out of the all-pervasive rudiment-matter (Bhútádi) appeared A'kása (ether), first as a Tanmátra (subtile matter) charged with the potential energy of sound (vibration-potential), and then as an atomic integration of a mono-Tanmátric structure (the A'kása-atom—आकाशाणु) also ubiquitous and all-enveloping. In the next stage we find a new kind of Tanmátras, systems of the infra-atomic vibratory particles, so arranged as to manifest a new form of energy, that of impact or mechanical pressure and these Tanmátras (सर्पतन्मात्राणि) combining with the vibration-potentials (A'kása Tanmátra) produced a new kind of atom, the di-Tanmátric Váyu-atom, which by aggregation formed a gaseous envelope composed of impinging (driving) vibratory particles (Váyu). Next appeared the third class of Tanmátras, infra-atomic systems of the impinging vibratory particles, which by their collocation developed a new form of Energy—the energy of radiant heat-and-light. These Tanmátras (स्पर्शतन्मात्राणि) combining with the potentials (Tanmátras) of vibration and impact, produced a new kind of atom—the tri-Tanmátric Tejas-atom, the light-and-heat corpuscle, which by aggregation enveloped the gaseous world in huge flames. In the next stage we have the fourth class of

Tanmátras, new and complex infra-atomic systems of the radiant impinging vibratory particles, which evolved the energy of viscous attraction as well as the potential Energy concerned in the taste-stimulus. These Tanmátras (रसतन्मात्राणि) combining with the three previous ones, gave rise to another class of atoms, the tetra-Tanmátric Ap-atom, and the flaming gases were thus precipitated into cosmic masses of viscous fluid matters (Ap). Finally appeared the fifth class of Tanmátras infra-atomic systems of the viscous radiant impinging vibratory particles which developed new forms of Energy—the Energy of cohesive attraction, as well as the potential energy concerned in the stimulus of smell. These Tanmátras (गन्धतन्मात्राणि) uniting with the other four kinds or infra-atomic subtile particles, formed another class of atoms, the penta-Tanmátric Earth-atom. Thus the viscous fluid matters were condensed and transformed into the Earth-Bhúta, comprising the majority of the so-called elements of chemistry.

The Puránas, in their own fanciful way, conceive that, in the course of cosmic evolution, each succeeding Bhúta appeared within an outer envelope of its immediate predecessor, with a total mass (or volume ?) a tenth less than that of the latter.

than the ordinary elements of chemistry (which are of a penta-Tanmátric structure),—are even now known. (तेजो भौमादिभेदेन बहुविधं । भौमं दिव्यं चोदर्थं आकरजं—वरवरमुनि,—तत्त्वत्रयभाष्य) ।

First, there is fire, or the light-and-heat emitted by the burning log of wood or lamp (अग्निः—दीपः—भौमं तेजः). Now it is important to note that the flame of a burning log of wood (द्रव्यम्) or an oil-lamp is not pure Tejas, a pure mass of light-and-heat corpuscles. There is chemical union with Earth-particles (particles of the hard penta-Tanmátric substance) acted on by Energy; and then the Tejas corpuscles, light-and-heat particles which are latent (absorbed) therein, come forth as flame (पार्थिवोपष्टब्धेन तदनुगतात् तेजसः अग्निर्भवति—विज्ञानमित्र—प्रवचनभाष्य. Súra 110, Chap. V). Then there is the light of the sun and the stars (दिव्यं सौरं चादित्यादि) which are flaming masses of molten viscous matters (जलमादेत्स्वभं तेजः दिव्यं तस्य सूर्यादि,—तत्त्वत्रयभाष्य, अचित्प्रकरण) or of molten earthy matters सूर्यादीनि सत्त्वाणि तेजांसि पार्थिवद्रव्यसङ्केतैव अवस्थितानि,—विज्ञानमित्र, प्रवचनभाष्य, Súra 13, Chap. III). There is also the lightning, which liberates a kind of Tejas latent in the aqueous particles and vapours, under the action of

Energy, in the same way as an ordinary fire liberates the Tejas latent in the wood or other fuel. Next there are the stores of animal heat derived from the break-up of the nutritive material (जीवद्वयं). Lastly there comes the peculiar form of the Tejas Energy (radiant Energy) stored up in the metalliferous ores and igneous rocks which have been formed in the subterranean heat. Here Earthy matters are mixed up, but the radiant Energy predominates in the composition of the metals (तेजसाधिक्येन तेजसादिता सुवर्णादीनां—विज्ञान-निष्ठ, प्रवचनभाष्य, Sūtra 19, Chap. III). Aniruddha, a late Sāṅkhya commentator, notes in reference to 'igneous bodies' that the greater part of their mass is derived from the Earth-Bhūta, though the Tejas particles determine the peculiar chemical combination, which produces them; and this must also be his view of the composition of the metals.

तत्र अपि (तेजसे प्ररीरे अपि) बहुतरपाणिंभावयवावट्प्रकल्प', अत्यन्ते आनुपमोगात् । (अनिरुद्धवृत्ति—Sūtra 112, Chap. V.)

4. Ap. This viscous fluid of a tetra-Tanmātrīc structure has but one pure example, viz., water, though the various organic acids, the juices of fruits and the saps of plants, are supposed to be transformations of watery radicles combined with different kinds of earthy accretions.

5. Lastly the Earth-Bhúta, the hard full-formed matter, with its penta-Tanmátric atoms, comprises by far the majority of the so-called chemical elements.

The question is,—how does one and the same Bhúta, of the same formal structure, comprise different kinds of elements, with different atomic masses, and different characteristic properties? And the answer is not far to seek. The properties of a thing are only the energies that are manifested in the particular collocations of the three Gunas,—Mass, Energy and Essence; and a tri-Tanmátric, or a penta-Tanmátric atom, *i. e.* an atom composed of three or of five kinds of Tanmátras may differ from another of the same class, in respect of the number of constituent Tanmátras of any particular kind, as also of their collocation or grouping, and therefore in mass as well as in generic and specific characters.

The Sāṅkhya-Pātañjala conceives the properties (or energies) of substances to result from the grouping or the quanta of the Tanmátras, or the Gunas themselves, and hence any radical differences in substances of the same Bhúta class must characterise their atoms, though in an infra-sensible form. In the Nyāya-Vaisesika, on the other hand, the atoms of the same Bhúta class are alike in themselves, homogeneous; and the

variety of substances comprehended under the same Bhûta, is ascribed merely to the different arrangements or groupings of the atoms (अणू) and not of their components, for components they have none.

As a typical and familiar instance of the variety of characteristic properties (or energies) that may result from variations in accompaniment or grouping, the Sāṅkhya-Pātañjala points to the various kinds of fruit acids and juices, all originating from one and the same Bhûta (water) with different accretions of earthy matters (भूविकाराः). In the same way, though we speak of only five classes of Tanmātras and atoms, the infinite variety of the world results from the infinitely varied collocations of the three original Gunas, which underlie Tanmātra and atom alike (सत्त्वरजस्तमसां अपकर्षकाष्टापन्नः संघातः परमाणुरिति—न्यायवार्तिक, उद्धृतकर, reporting the Sāṅkhya view : अयुतसिद्धावयवः संघातः परमाणुरिति—व्यासभाष्य, Sūtra 44, Pada III.—परमाणुः सामान्यविशेषाभ्यामयुतसिद्धावयवभेदानुगतः समुदायः—व्यासभाष्य, Sūtra 44, Pada IV,—योग्यतावाञ्छन्ना धर्मिणः शक्तिरेव धर्मः (ibid., Sūtra 14, Pada III.) यो धर्मस्तु अनुपाती सामान्य-विशेषाभ्यामसिद्ध्यो धर्मो (ibid., Sūtra 14, Pada III).

खादितम्—कथं एकरूपाणां गुणानां अनेकवदा प्रवृत्तिः—इत्यत आह परिणामतः सलिलवत् । यथा वारिद्विमुक्तं उदकं एकरसं अपि तत्तद्विविकारात् आसाद्य नारिकेल-तासी-विल.

चिरविद्य-तिन्दुकानसक-कपित्थफलरसतया परिणामात् सधुराकलवच-
 तिलकटुकवायतया विवक्ष्यते, एवमेकैकगुणसम्भवात् प्रधानं गुणम् चात्रिल
 चप्रधानगुणाः परिणामभेदान् प्रवर्धयन्ति । तदिदमुक्तं प्रतिप्रतिगुणान्वय-
 विशेषात्, एकैकगुणान्वयेषु यो विशेषस्तस्मात् इत्यर्थः ।

(वाचस्पति—कौमुदी—On Káriká 16.)

If we take a unit of rudiment-matter (Bhútádi) for the unit of mass (cf. the mass of an electron with a charge of motion etc.), and represent the first Tanmátra by t_1 such units, and if further, t_2, t_3, t_4, t_5 units of mass (Bhútádi) be successively added at each accretion to form a fresh Tanmátra, then the second, third, fourth and fifth Tanmátras will respectively contain $t_1 + t_2, t_1 + t_2 + t_3, t_1 + t_2 + t_3 + t_4$, and $t_1 + t_2 + t_3 + t_4 + t_5$ units of mass.

Also the Váyu atom (bi-Tanmátric system) will contain $t_1 + (t_1 + t_2)$, i.e. $2t_1 + t_2$ units of mass ; the Tejas-atom (tri-Tanmátric system) will contain $t_1 + (t_1 + t_2) + (t_1 + t_2 + t_3)$ i.e. $3t_1 + 2t_2 + t_3$ units ; the Ap-atom (tetra-Tanmátric system) $t_1 + (t_1 + t_2) + (t_1 + t_2 + t_3) + (t_1 + t_2 + t_3 + t_4)$, i.e. $4t_1 + 3t_2 + 2t_3 + t_4$ units ; and the Earth-atom (penta-Tanmátric system), $t_1 + (t_1 + t_2) + \dots + (t_1 + t_2 + t_3 + t_4 + t_5)$, i.e. $5t_1 + 4t_2 + 3t_3 + 2t_4 + t_5$ units.

If t units of mass be added to the first Tanmátra to form the atom of A'kása, the latter will contain $t_1 + t$ units of mass.

In other words the numbers representing the mass-units (Tamas) in the different classes of atoms (gross matter) will form an ascending series, viz. $t_1 + t$, $2t_1 + t_2$, $3t_1 + 2t_2 + t_3$, $4t_1 + 3t_2 + 2t_3 + t_4$, and $5t_1 + 4t_2 + 3t_3 + 2t_4 + t_5$.

Now if a follower of the Sāṅkhya-Pātañjala were asked to account for differences among Paramānus of the same Bhūta class, he would perhaps suppose t_1 to vary from α_1 to β_1 , t_2 from α_2 to β_2 , t_3 from α_3 to β_3 , t_4 from α_4 to β_4 and t_5 from α_5 to β_5 .

Therefore the mass-units contained in the Vāyu-atoms of the different possible Vāyu substances would be represented by $2\alpha_1 + t$, $2\alpha_1 + 1 + t$, $2\alpha_1 + 2 + t$, $2\beta_1 + t$, in A. P. with unity as common difference, there being $2(\beta_1 - \alpha_1) + 1$ possible Vāyu substances.

The mass-units contained in the Tejas-atoms of the different possible Tejas substances would be represented by the series, $3\alpha_3 + 2\alpha_2 + \alpha_1$, $3\alpha_3 + 2\alpha_2 + \alpha_1 + 1$, $3\beta_3 + 2\beta_2 + \beta_1$, increasing in A. P. by unity as common difference, then being $3(\beta_3 - \alpha_3) + 2(\beta_2 - \alpha_2) + (\beta_1 - \alpha_1) + 1$, Tejas substances possible.

The mass-units contained in the Ap-atoms of the different possible Ap-substances would form the series $4\alpha_4 + 3\alpha_3 + 2\alpha_2 + \alpha_1$, $4\alpha_4 + 3\alpha_3 + 2\alpha_2 + \alpha_1 + 1$, $4\beta_4 + 3\beta_3 + 2\beta_2 + \beta_1$, there being $4(\beta_4 - \alpha_4) + 3(\beta_3 - \alpha_3) + 2(\beta_2 - \alpha_2) + (\beta_1 - \alpha_1) + 1$ Ap-substances possible.

The mass units contained in the Earth-atoms of the different possible Earth-substances would form the series in A. P., $5\alpha_1 + 4\alpha_2 + 3\alpha_3 + 2\alpha_4 + \alpha_5$, $5\alpha_1 + 4\alpha_2 + 3\alpha_3 + 2\alpha_4 + \alpha_5 + 1, \dots, 5\beta_1 + 4\beta_2 + 3\beta_3 + 2\beta_4 + \beta_5$, there being $5(\beta_1 - \alpha_1) + 4(\beta_2 - \alpha_2) + 3(\beta_3 - \alpha_3) + 2(\beta_4 - \alpha_4) + (\beta_5 - \alpha_5) + 1$ Earth-substances possible.

Size (परिमाण).—As to size or volume, the Sāṅkhya accepts only two kinds,—the infinitesimal, which is also without parts (अणु—निरवयव) and the non-infinitesimal, which consists of parts (सङ्खत्—समवयव). The latter varies from the excessively small (the so-called Anus. Tanmātras and Paramānus) to the indefinitely great (परमसङ्खत्—विशु,—e.g.—A'kāśa).

The Gunas alone are infinitesimal, with the exception of those ubiquitous ones that evolve into A'kāśa-atoms and Mind-stuff (आकाशाणु and चक्षुःकरण):—all the rest of the evolved products (whether subtile or gross matter) are non-infinitesimal.

Vijñānabhikṣhu notes that all the Gunas (Reals) cannot be ubiquitous. If this were the case, that disturbance of equilibrium, that unequal aggregation with unequal stress and strain, with which cosmic evolution begins, would be impossible. The Gunas, which give rise to A'kāśa and Mind-stuff, must be held to be ubiquitous, and this will suffice for the ubiquity of Prakṛiti,

(न च अद्यहर्षने गुणस्थानप्रकृतेः विभुत्वमेवावगम्यते इति वाच्यम् ।
अतःकारणाकारादेतुगुणानां विभुत्वेन तदुपपत्तेः । सर्वगुणानां विभुत्वे
सति चाद्यपरिणामहेतुबीजसंयोगाद्यसंभवात् (बीजवार्त्तिक, Sūtra 51,
Pada III.)

Chemical analysis and Synthesis—Elements and Compounds.

What then is the equivalent in the Sāṅkhya-Pātañjala of the distinction between a chemical element and a chemical compound, or is there none ? Did or did not this elaborate physical analysis and classification of things lead on to a classification based on chemical analysis and chemical synthesis ? These are questions of singular interest, the answer to which will disclose some new points of view from which the ancient Hindu thinkers approached the problems of chemical physics and physical chemistry.

Aggregates (समूहाः) may, in regard to their structure, be divided into two classes, (1) those of which the parts are in intimate union and fusion, being lost in the whole (अयुतसिद्धावयवाः समूहाः) ; and (2) mechanical aggregates, or collocations of distinct and independent parts (युतसिद्धावयवाः समूहाः).

A substance is an aggregate of the former kind, and may be divided into two classes, (1) the Bhūtas and their 'isomeric' modifications भूत, भूतमेद and भूतविहार) ; and (2) chemical compounds (निश्चितद्रव्य,

संज्ञतमूलात्). Chemical compounds again may be subdivided into two classes, (1) those composed of atoms of the same Bhúta class, i.e. of different isomeric modifications of the same Bhúta, and (2) those composed of atoms of different Bhúta classes. In the first case, there is contact between 'isomeric' atoms (सजातीय-संयोग), in the second case, between heterogeneous or 'polymeric' ? atoms (विजातीय-संयोग). The first contact leads to intimate union (सङ्गः—सङ्गाध्यः यः संयोगविशेषः तेनैव द्रव्याणां विकारो भवति—विज्ञानमिश्र प्रवचनभाष्य): the isomeric atoms by a peculiar liberation of Energy (सजातीयोपटन्त्र—the action of similars on similars) are attracted towards one another, and being riveted as it were, form the so-called material cause (उपादान कारण) of the compound product. The second kind of contact (that between unlike or 'polymeric' ? atoms of heterogeneous Bhútas) begins with a liberation of Energy (उपटन्त्र), which breaks up each of the Bhútas, and taking particles (or atoms) of one as nuclei or radicles groups particles of the rest round these radicles in a comparatively free or unattached condition. In this case, one Bhúta, that which serves to furnish the radicles, not necessarily that which is numerically or quantitatively predominant, gets the name of material cause (उपादानकारण), and the others, which by their collocation cause the liberation of Energy (उपटन्त्र, अवटन्त्र or विटन्त्र),

are called efficient causes (निमित्त कारण)—एवमेकैक-
 गुचसम्भवात् प्रधान गुचमात्रित्वं अप्रधानगुणाः परिवर्तमानभेदान्
 प्रवर्तयन्ति—वाचस्पति, कौमुदी on Kárika 16. The illus-
 tration given (viz. the Rasas as modifications of
 Ap, water, with Earth-accretions) show that this
 process applies not only to the Gunas, but also to
 the Bhútas. यथा अकाशादिकरसं सलिलं पतितं नानाकृपात्
 संज्ञेनात् भिद्यते—(गौड़पाद on Káriká 17).—तत्र अपि (तेजसं
 शरीरे अपि) बहुतरपार्थिवावयवावष्टम्भात् स्वल्पे च अनुपभोगात् (अनिर्दुष्ट
 on Súra 112, Chap. V), आतिसाद्व्यस्य अद्याकनदीवत्वात्
 सामयौसमवधाने अनेकैरपि इन्द्रियैः एकदा एकदृष्ट्युत्पादने वाचकं नास्ति
 (विज्ञानमिश्र—प्रवचनभाष्य).

Aniruddha goes so far as to hold that both
 'isomeric' and 'polymeric' (or 'heterogenic') com-
 binations are real cases of constitutive contact,
 (आरम्भकसंयोग, e.g. औतिकवायोर्देहधारणकत्वम्—अनिर्दुष्ट on Súra
 113, Chap. V.) But in the later Sāṅkhya-Pātañjala
 the current teaching denied this—बह्वानुपादानाद्योगात्
 (Súra 102, Chap V), when विज्ञानमिश्र notes—बह्वानां
 भिन्नजातीयानां उपोपादानत्वं न दृष्टमिति सजातीयमेवोपादानम् । इतरञ्च
 सूतचतुष्टयमुपपन्नकम् ।

But besides these transformations of substance
 (द्रव्यान्तर-परिवर्तन) by 'isomeric' or 'heterogenic'
 process, ceaseless changes go on in the characters,
 the modality, and the states of substances—changes

which are due to the unequal distribution of force (or of stress and strain,—pressure) among the Gunas, which are in themselves constant. (चर्च-
खण्डवावस्थापरिचयः न द्रव्यान्तरतः,—यथा एका रेखा व्रतस्थाने व्रत
दशस्थाने दश, एकचक्रस्थाने, यथा चैकत्वेऽपि स्त्री माता जीयते दुहिते
च स्वसा चति,—गुणिनिष्ठत्वेऽपि गुण, न विमर्दवेदित्वात्—व्यासभाष्य,
Sútra 13, Pada III.)

“Even as the same figure ‘1’ stands for a hundred in the place of hundred, for ten in the place of ten, and for a unit in the place of unit.”*

* This conclusively proves that the decimal notation was familiar to the Hindus when the Vyása-Bhāshya was written, i.e. centuries before the first appearance of the notation in the writings of the Arabs or the Greco-Syrian intermediaries. Vāchaspati, who comments on the Vyása-Bhāshya, composed his Nyāya-Sūchi-Nibandha in बल्लभसुवर्णरे i.e. Samvat 898 or 842 A. D. This cannot be S’aka 898, for apart from the decisive use of बत्सुर, which by this time had come to signify the Samvat era, Vāchaspati’s commentator Udayana, wrote the Lakṣanāvalī in S’aka 906—

तर्कान्तरादुपमितेवतीतिषु प्रकाशतः ।

वर्षेन्दुद्वयमक्षरे सुबोधा खण्डवादसीम् ॥

and Udayana, who wrote the Parisuddhi on the Tātparyya-tīkā of Vāchaspati, could not have been a contemporary of the latter, as will also appear from the invocation to Sarasvati in the opening lines of the Parisuddhi. Vāchaspati then preceded Udayana by 142 years, and must have been himself preceded by the author of the Vyása-Bhāshya by a

Now the question is—in these mixed substances does the fusion take place by Paramānus or by larger masses (or lumps) ? Now a Paramānu is defined to be the smallest portion of any substance which exhibits the characteristic qualities of that substance,—in other words, it stands for the smallest homogeneous portion of any substance. It is not without parts and therefore not indivisible. It is subject to disintegration. In a Bhūta or its isomeric modification, the Paramānu, the smallest homogeneous component particle, is unmixed, and therefore corresponds to the atom of modern chemistry. In a mixed substance (मिश्रितद्रव्य, संवृतभूतार्थ) whether it is an 'isomeric' or a 'polymeric' compound, the qualities are due to the mixture, and therefore its Paramānu, the smallest homogeneous particle possessing its characteristic qualities, must result from the mixture of the Paramānus (in smaller or larger numbers as the case may be) of the component substances. The Para-

longer interval still, for Vāchaspati ascribes the Bhāshya to Veda-Vyāsa himself (वेदव्यासेन भाषिते भाष्ये व्याख्या विधासते). The internal evidence also points to the conclusion that the Bhāshya cannot have been composed later than the sixth century,—cf. the quotations from Pañchasikha, Vārshaganya, and the Shashī-Tantra-S'āstra, without a single reference to I'svara-Krishna—which is decisive. I may add that I remember to have come across passages of a similar import in Buddhist and other writings of a still earlier date.

mānu of a mixed substance therefore corresponds to what we now call molecule. (अपकर्षपर्यन्तं द्रव्यं परमाचुरिति—व्यासभाष्य । खोदस्य हि प्रविभज्यमानस्य यस्मिन्नवयवे अस्य तत्तारतम्यं व्यवतिष्ठते सः अपकर्षपर्यन्तपरमाणुः—वाचस्पति—तत्त्ववैशारदी—Sūtra 52, Pada III.—नाचुनित्यता न निर्भागत्वं । पृथिवीपरमाणुः जलपरमाणुरित्यादिव्यवहारस्तु पृथिव्यादीनामपकर्षकाङ्गाभिप्रायेणैव । विज्ञानमिच्छुः—प्रवचनभाष्य, Sūtra 88, Chap. V.)—That the Paramānus form molecules (वाचक) in forming substances, is acknowledged by the Sāṅkhyas as will appear from Gaudapāda,—तथा चन्वीन्याययाच वाचुकवदगुणाः । (गौडपाद, on Kārikā 12). Even the Vaiśeṣikas, with their prejudice against 'polymeric' or 'heterogenic' combination, acknowledge that in 'polymeric' compounds the different Bhūta substances unite by their Paramānus (or atoms), though they rigidly insist that in such cases only one atom should be regarded as the 'radicle' (उपादान or द्रव्यान्धककारण) and the others as co-efficient causes (निमित्तकारण—उपटन्धक), e g. प्रत्यक्षपाद—एवं समुत्पन्नैश्च चतुर्षु महाभूतैश्च महेन्द्रसामिध्यानमावात् तैजसीभीऽणुभ्यः पार्थिवपरमाणुसहितेभ्यो महदहंमुत्पद्यते (प्रत्यक्षपादभाष्य—where S'rīdhara notes पार्थिवं अवयवा उपटन्धकाः and Udayana तैजसानां परमाणूनां पार्थिवाणुसहितेन अवयवेन हिरण्यकलं विवर्धितं) ।

It is only in the mediæval Sāṅkhya-Pātañjala that under the influence of the Nyāya-Vaiśeṣika doctrine a radical difference was conceived to exist between the structure (or constitution) of a molecule composed of 'isomeric' atoms, and that of one composed of heterogeneous (or 'polymeric'?) atoms. In the former case, there was believed to take place intimate union (सङ्ग), in the latter case, only a grouping of comparatively free or loosely attached atoms round a radicle atom (मूलक), with liberation of Energy (उपपत्ति, —व्यवपत्ति—or विपत्ति) and the setting up of unequal stress and strain (गुरुत्वेवम्यदिमर्द—ईश्वरकृत्). At the same time, it was of course admitted that this distinction does not apply to the forms of subtile matter (Tanmātra—सूक्ष्मभूत) which could unite in intimate fusion, whether homogeneous or heterogeneous. For example, the subtile body (सूक्ष्मशरीर) which is supposed to be the seat or vehicle of the conscious principle is acknowledged by Vijñāna-bhikṣhu to be penta-Bhautic (पञ्चभूतात्मक); in other words, all the five Tanmātras serve as material causes, though the gross body (the animal organism) is stated to be only a 'polymeric' compound with the Earth-Bhūta as radicle or base. अधिष्ठानशरीरं च सूक्ष्मं पञ्चभूतात्मकं वक्ष्यते । तन्मात्राणां यत् भूतपञ्चकं विज्ञाविज्ञानं शरीरम् (प्रवचनभाष्य—Sūtras

11 and 12, Chap. III.—स्थूलसूक्ष्मौ पाण्डुरौ च कृष्णौ च
मृताणि उपपद्यन्तानि (*ibid.* Sūtra 19, Chap. III.)

But in the original Sāṅkhya-Pātañjala it appears that the production of a new substance by mixture of unlike Bhūtas (विजातीयसंयोग) was conceded as freely as in the Vedānta, and was conceived as nowise differing from the formation of a compound of atoms of the same Bhūta class. The Sāṅkhya analysis of all change into transformations of Energy due to collocations of unchanging Gunas, in other words, the prevailing chemico-physical (or physical) point of view, naturally recognises no distinction between collocations of 'isomeric' and those of heterogeneous (or 'polymeric'?) atoms. At bottom they are all collocations of the Gunas. Even Vijñāna-bhikṣu who, as one of the latest expounders of the Sāṅkhya-Pātañjala, has been most affected by the Vaiśeṣika prejudice against 'polymeric' combination (विजातीयसंयोग) urges that the qualities of a compound substance are not necessarily the result of similar qualities in the component elements. (सजातीय-कारणगुणस्यैव कार्यगुणारम्भकता इति तु तेषां (तार्किकाणां) अपि न नियमः।) Elsewhere he explains that far from the vital activity being independent it is originated and maintained by the combined operation or fusion of the different sensory and motor reflexes of the living

organism, and notes that the united operation of mixed (or miscellaneous) causes, where there is a fit collocation of matter, offers no difficulty to a follower of the Sāṅkhya-Pātañjala :—(जातिसादृश्यस्य चक्ष्माकनदी-
 पत्वात्, सामयौसनवधाने सति अनेकैरपि इन्द्रियैः एकदा एकवस्तुत्-
 पादने बाधकं नास्ति—प्रवचनभाष्य, Sūtra 32, Chap. II). In the middle of the ninth century, we find Vāchaspati instancing some 'heterogenic' or 'polymeric' compositions as typical examples of evolutionary change (परिणाम) and unhesitatingly accepting the substantive character of the products. In the Kaumudī he describes the various acids and juices of fruits as modifications of the same original water in the presence of different kinds of earthy accretions. The process is peculiar. The water-particle (or atom) serves as a radicle or centre of a system, and the different kinds of the Earth-Bhūta centering round this as a nucleus become the seat of forces, which bring in the development of new energies (and new qualities, *e.g.* tastes) in the water. यथा वारिद्विमुक्तमुदकं
 एकरसमपि तप्तद-भूतविकारान् आसाद्य नारिकेल-ताली-बिल्व-कपित्थादि-
 रसतया परिणामात् मधुराकलषणतिक्तकटुकषायतया विकल्पते । इति
 एकैकगुणसम्भवात् प्रधानगुणम् आश्रित्य अप्रधानगुणाः परिणामभेदान्
 प्रवर्तयन्ति । (कौमुदी on Kārikā 16). Vāchaspati also points out that different substances may be transformed into one and the same substance (*e.g.*

the production of salt by the cow, the horse, the buffalo and the elephant, thrown into the salt factory of Sambara in Rajputana or of the flame of a candle by the combination of wick, oil and fire. (परिणामेकत्वं बहूनामपि एकः परिणामः दृष्टः । तद्वयथा गवाऽश्व-
महिषमातङ्गानां समानिस्तितानां एकलवणत्वजातीयलवणः परिणामः,
वर्तितैलानलानां च प्रदीप इति ।—तत्त्ववैशारदी on व्यासभाष्य, Pada
IV. Sūtra 14.)

Earlier still, *i.e.*, not later than the sixth century, the Vyāsa-Bhāṣhya, noting that inorganic matter, vegetable substances and animal substances do not differ from one another essentially in respect of their potential energies and ultimate constituents, points out that various bi-Bhautic chemical compounds of water and earth substances, in the shape of saps, acids and juices, are found in plants in their different parts (जलभूम्योः पारिणाभिकं रसादिवैश्वक्यं स्थावरैषु दृष्टम्). In other words, bi-Bhautic compounds are here placed in the same category as 'isomeric' compounds of substances of the same Bhūta class, for here the particles of both the Bhūtas are regarded as forming the matter (material cause—उपादानकारण) of the smallest homogeneous portions of the compound substances.

N.B.—Vāchaspati naturally interprets this to mean separate modifications of the two Bhūtas.

The view of the earlier Sāṅkhyas that atoms of different Bhūtas may chemically combine to form molecules of compound substances as much as atoms of different modes of the same Bhūta comes out clearly in Utpala's brief reference to the Sāṅkhya system in his commentary on Varahamihira's *Vrihat Samhita*. (एभ्यः पञ्चभ्यः [तन्मात्रेभ्यः] पञ्चमहाभूतानि भवन्ति । तेभ्यः शरीरेणां शरीराणि । यतः पञ्चमहाभूतमयाणि शरीराणि Utpala, Chap. 1, S'loka 7).

Chemistry in the medical schools of ancient India :—As a matter of fact, long before the fifth century, probably as early as the first century A. D., the prevailing schools of medicine and surgery which were based on the S'āṅkhya teaching with a methodology derived from the Nyāya-Vaisesika doctrine (cf. Charaka, S'ārīrasthāna, Chap. I, Vimānasthāna, Chap. VIII—also Susruta, S'ārīrasthāna, Chap. 1) had founded an elaborate theory of inorganic and organic compounds, which equally admitted isobhautic and hetero-Bhautic combinations. Like the Vedantists, Charaka held that each of the gross Bhūtas (Mahābhūtas) is a peculiar ultra-chemical compound of five original subtle Bhūtas. In this sense, every substance is penta Bhautic, but for purposes of chemical analysis and synthesis, i. e. considered with reference to the Mahābhūtas, all substances in their chemical constitution, belong to

one or other of the following classes : Mono-Bhautic, bi-Bhautic, tri-Bhautic, tetra-Bhautic, and penta-Bhautic. Compounds of different Bhútas, again, may combine to form more complex substances, and these in their turn, higher compounds still, and so on in progressive transformation, as is more specially the case with organic substances and products.

Physical characters of the Bhútas :— The prevailing physical characters of the different Bhútas and their isomeric modes are enumerated as follows.

Earth-substances—Heavy, rough, hard, inert,
dense, opaque, exciting
the sense of smell.

Ap-substances—Liquid, viscous, cold, soft,
slippery, fluid, exciting the
sense of taste.

Tejas-substances—Hot, penetrative, subtle, light,
dry, clear, rarefied, and
luminous.

Váyu-substances—Light, cold, dry, transparent,
rare-fied, impingent.

A'kása-substances—Imponderable (or light),
rarefied, elastic, capable of
sound (vibrations).

(बुधवारकठिनमन्दस्विराविषद्वान्-सूक्ष्ममृगुचवद्वानि पार्थिवानि ।
द्रवस्निग्धप्रीतमन्दवद्वपिस्त्रिष्वरसमुच्चवद्वानि द्वायानि । उत्तरीष्वरस-
मुच्चवविषद्वपमुच्चवद्वानि आग्नेयानि । सप्तप्रीतवद्वरविषद्वान्-अम-)

गुणबहुलानि वायव्यानि । अदुलघुनूच्छन्नश्वाशब्दगुणबहुलानि आकाशात्म-
कानि ।—Charaka, S'árirasthána, Chap. 26 ; compare
Susruta, S'útrasthána, Chap. 41).

Charaka points out that the primary qualities or specific physical characters of the five Bhútas are tactile qualities, *i. e.* sensible to touch, *e. g.* hardness (or roughness) for Earth, liquidity (or yielding to pressure) for Ap, impelling or moving force (pressure) for Váyu, heat for Tejas, and Vacuum (non-resistance, penetrability) for A'kasa.

(खरद्रवचलोत्थलं भूजलानिलतेजसाम्,

आकाशस्याप्रतीचाती दृष्टं लिङ्गं यथाक्रमम् ।

लघवं सर्वमेवेतत् स्थानेन्द्रियगोचरम् ।

Charaka-S'árirasthána, Chap. I.)

(cf. the elaborate enumeration of physical characters quoted in Vijñána-bhikṣu, Yoga-Vártika, Sutra 42, Pada I ;—also Varavara's commentary on Tattva-traya Achit-prakarana).

The Mahá-Bhútas—mechanical mixtures :—
Susruta notes that each of the gross Bhútas (Mahá-bhútas) is found mixed up with the other Bhútas ; —*e. g.*, the Mahábhúta A'kasa is the receptacle (or vehicle) of air, heat-and-light, and water vapour ; the Mahábhúta Váyu, of water-vapour, light-and-heat, and even fine particles of Earth held in suspension ; the Mahábhúta Tejás, of earth-particles in the shape of smoke, and also water-vapour.

(अन्योऽन्यानुप्रविष्टानि सर्वान्येतानि निर्दिशेत्—Susruta, Sārīra-
sthāna, Chap. I.) अन्ये पुनः अन्यथा व्याचक्षते। आकाशे पवन-
दहन-तोयानि। वायौ तेजोऽम्बुनी। भूरपि अणुताविशेषेण। भूमिरपि
धूमादिरूपेण तेजसि। तेजोद्रव्यं पानीयमपि।—Dalvana on
Susruta, loc. cit.)

Mono-Bhautic Earth-substances :—Charaka and
Susruta regard the following as Earth-substances—
Gold, the five Lohas (silver, copper, lead, iron and
tin) and their 'rust', arsenic, orpiment, various
mineral earths and salts. sand, precious stones,
(Charaka, Sūtrasthāna, Chap. I. Cf. also Susruta,
Sūtrasthāna, Chap. I—पाथिवाः सुवर्णरजतमणिसुक्तामनः-
शिलासूक्तपाशादयः। सुवर्णस्य दृढं पार्थिवत्वमेवाङ्गीक्रियते गुह्यत्वकाठिन्य-
स्थेय्यादिरुतुभिः। सृष्टेः आदिरुदणात् लोहमलसिकतासुषाहरिताल्लवण-
नैरिकरसास्त्रज प्रभृतीनां—Dalvana on Susruta, loc. cit.)

The salts include common salt, saltpetre, etc.
Susruta mentions, the alkalis, borax, natron,
Yavakshāra (carbonate of potash) etc. The Audbhida
salt, an inflorescence of the soil, stands for *reh* (चोद्विदं
पाथलवर्णं यज्जातंभूमितः खयम्).

Of these Earth-substances, some were known
to be compounds, *e. g.* the chemical salts of the
metals, collyrium etc. Susruta describes the pre-
paration of the metallic salts. The leaves of the
metals were pasted over with the salts, and then
roasted (अयस्कृति) (Chikitsāsthāna, Chap. 10).
These metallic salts are therefore mono-Bhautic
Earth-compounds. Susruta also gives the preparation
of mild and caustic alkalis. (Sūtrasthāna, Chap. 11.

Origin of precious stones :—Some hazarded the guess that the precious stones are rocks (or earths) metamorphosed by natural process in the course of ages (Varāhamihira—वेचिर्वा प्रादुर्भवन्नामान् कैचित् सुवः स्वभावात्—Utpala notes, —रत्नरूपत्वं प्राप्ताः कालान्तरेण).

Ap-substances, simple and compound :—

Susruta, following Charaka, enumerates various classes of Ap substances (द्रवद्रव्य) as follows :—waters, acids, milks, curds, butters, oils (vegetable as well as animal), fats, honeys, molasses, alcoholic liquors, urines etc.

Pure Ap (Mahābhūta) is tasteless and the six tastes are developed when the Mahābhūta Ap enters into combination, mechanical or chemical, with other Mahābhūtas. Susruta notes that various kinds of Earths are dissolved in the waters of different localities, and where the particles so dissolved are predominantly Earthy, the water tastes acid or salt,—where predominantly watery, the resulting taste is sweet,—where the Earth particles are mixed up with Tejas, the water tastes pungent or bitter etc. Such is the case with mechanical mixtures. In the case of bi-Bhautic or tri-Bhautic compounds Charaka mentions that substances with Mahābhūta Ap predominating in their composition taste sweet; with Mahābhūtas Earth and Tejas predominating, acid; with Mahābhūtas Ap and Tejas predominating, salt; with Mahābhūtas Vāyu and Tejas predominating, pun-

gent ; with Mahābhūtas Vāyu and Ākāśa predominating, bitter ; and with Mahābhūtas Vāyu and Earth predominating, astringent (Charaka, Sūtrasthāna, Chap. 26,—cf. Susruta, Sūtrasthāna, Chap. 42).

In fact with the exception of Susruta's waters which are mechanical mixtures, or rather solutions, all these Ap-substances are organic products and, as such, penta-Bhautic, *i. e.* compounded of all the five Mahābhūtas, and the particular 'taste' which is developed depends on the relative proportion of the Mahābhūtas, and the predominance of one or more of them in the penta-Bhautic compound in question.

Qualities of Compounds.—The isomeric modes of each Mahābhūta have specific colours, tastes etc. due to their structure, *i. e.* the arrangement of their atoms, and the physico-chemical characters of compounds whether of the same or of different Mahābhūtas result from the collocation in unequal proportion of the different forces latent in the atoms of the component substances. Charaka adds that the varied forms (textures) and colours of organic substances, whether vegetable or animal,, are derived in the same way. एकमेतेषां रसानां चतुस्त्वयस्य भूतानातिरेकविशेषात् नष्टाभूतानाम् । भूतानामिव स्वावरणकृतानां नानावर्णाकृतिविशेषाः ।

Susruta ignores Charaka's distinction between Mahābhūta and subtle Bhūta, and views every

substance as in reality penta-Bhautic and it is only the relative predominance of a particular Bhúta or Bhútas in any substance that determines its class. (पृथिव्यप्तेजीवाद्याकाशाणां समुदायान् द्रव्याभिनिर्दिष्टः । उत्कर्षस्तु अभिव्यक्तो भवति इदं पार्थिवं इदं वाय्वं इदं तेजसं इदं वायव्यं इदं आकाशीयमिति । Susruta, Sūtras-thāna Chap. 41)

The extant Charaka and Susruta—Succession of medical authorities :—

The extant Charaka and Susruta, the sources of our present information regarding the progress of scientific knowledge in the medical schools of Ancient India, are both redactions of original authorities. The extant Charaka is a redaction by Dridhabala of the genuine Charaka Samhitā which was itself a redaction by Charaka of the original work of Agnivesa, the disciple of A'treya Punarvasu as distinguished from Krishnātreya and Bhikshu A'treya, also well-known medical authorities. The extant Susruta is a redaction by Nágārjuna of an original work (Vridhha Susruta) by Susruta, the disciple of Dhanvantari. That Charaka preceded Susruta is almost certain. Nágārjuna was probably earlier than Dridhabala. At any rate, Dridhabala imported into Charaka much of the surgical knowledge which had till then been the traditional heritage of the Susruta school. And in the matter of the surgical treatment of certain diseases, the genuine Dridhabala is often as

advanced as Susruta's redactor himself. The latter was probably identical with the alchemist Nágárjuna (Siddha Nágárjuna), the metallurgist Nágárjuna (author of a treatise on metallurgy, Lohasástra), and the Buddhist Nágárjuna, author of the Mádhyamika-sútravritti. Charaka and Susruta continued to receive additions after Drīdhabala and Nágárjuna, and even after Vāgbhata, but the whole of the extant Charaka is probably much earlier than the commentator Chakrapāni, and the whole of the extant Susruta earlier than Dalvana, the commentator, and Mádhyava, the author of Rugvinischaya. The extracts in Vāgbhata make it certain that the passages I have quoted or shall quote from the Sūtrasthāna and S'árīrasthāna of Charaka and Susruta cannot be later than the sixth century of the Christian era.

Preparation of Chemical Compounds.—The knowledge of chemical compounds and of their preparation continued to make progress in the Charaka and Susruta Schools. The great metallurgist, Patañjali, in his treatise on Metallurgy (धौव्यात्मिका) gave elaborate directions for many metallurgic and chemical processes specially the preparation of the metallic salts, alloys and amalgams, and the extraction, purification and assaying of metals. Probably it was Patañjali who discovered the use of the mixtures called Vidas.

which contained aqua regia or other mineral acids in potentia. Unfortunately Patañjali's *magnum opus* appears to have been lost, but extracts from it are frequently found in mediaeval works on Medicine and Rasáyana, which leave no doubt as to its remarkable scientific value. The metallurgist Nágárjuna advanced the knowledge of chemical compounds by his preparations of mercury. The Harshacharita, in the seventh century, relates a fable concerning this Nágárjuna, and speaks of him as a friend and contemporary of Sátaváhana. The relative priority of Patañjali and Nágárjuna is a vexed question in the history of metallurgy. That Nágárjuna's Lobasástra was earlier than the final redaction of Patañjali will appear from the following circumstances :—(1) Chakradatta in his summary of Nágárjuna mentions that the chemical process of testing pure iron must be repeated twice before it can be regarded as decisive, whereas S'ivadása Sen's extract from Patañjali shows that the latter directed the process to be repeated seven times ; (2) Patañjali in the Abhrika-vidhi (mica operation) adds mercury, which in this particular operation is wanting in Nágárjuna's recipe (cf. Chakradatta, and Patañjali as reported in the Yogoratránákara-samuçchaya) ; and (3) Nágárjuna is quoted in the earlier compilations, Patañjali in the later.

Early in the sixth century, Varāhamihira in the

Vrihat Samhitá gives several preparations of cements or powders called *Vajra-lepa* "cements strong as the thunderbolt;" and there was ample use for these in the temple architecture of the Buddhist period, the remains of which bear testimony to the adamant strength of these metal or rock cements. (प्रासाददृक्कावलीलिङ्ग-प्रतिमासु कुचकूपेषु सन्तप्तौ दातव्यौ वर्षवह्नायुतस्यायौ । Chapter 56, *Ibid.*). Varáhamihira also alludes to the experts in machinery (यन्त्रविदः, यन्त्रज्ञाः) and the professional experts in the composition of dyes and cosmetics (रागगन्धयुक्तिविदः Ch. 16, also Ch. 15). I would also refer to the interesting Chapter on Perfumery (Ch. 76) where Varáhamihira gives various recipes for artificial imitations of natural flower scents as of the essence of *Vakula*, *Utpala*, *Champaka*, *Atimuktaka* &c., arranges compound scents in a sort of scale according to the proportions of certain ground essences used in their preparation, and determines by the mathematical calculus of combination (लोष्टकप्रसार) the number of variations of the different notes in this scale. To these classes of professional experts were due three of the great Indian discoveries in the chemical arts and manufactures which enabled India to command for more than a thousand years the markets of the East as well as the West and secured to her an easy and universally recognised pre-eminence among the nations of the world in

manufactures and exports :—(1) the preparation of fast dyes for textile fabrics by the treatment of natural dyes like Mañjishtā with alum (सुवरी मज्जिहा रागवन्धिनी) and other chemical (*e. g.* sulphate of iron) also cow-dung (cf. the “cowdung substitute”, Roscoe); (2) the extraction of the principle of indigotin from the indigo plant by a process which however crude is essentially an anticipation of modern chemical methods; and (3) the tempering of steel in a manner worthy of advanced metallurgy, a process to which the mediæval world owed its Damascus swords. It was this applied chemistry much more than handicraft skill which gave India her premier position in the middle ages and earlier (indeed from Pliny to Tavernier) in exports and manufactures; for in handicraft skill as in design and workmanship, great as were her merits, India came to be surpassed by her disciples China and Japan.

The Vāsavadattā and the Dasakumāra Charita in the sixth century allude to the preparation of a mass of fixed or coagulated mercury (पारद-पिण्ड इव कासधातुवादिनः—वासवदत्ता); a chemical powder, the inhalation of which would bring on deep sleep or stupor (योगवर्ण—दशकुमारचरित); a chemically prepared stick or wick for producing light without fire (योगवर्णिका—दशकुमारचरित); and a powder which like anæsthetic drugs or curare, paralyses

sensory and motor organs (*संज्ञानकर्षणनिब इन्द्रियावाह-
—वासवदत्ता—वीन्द्रियकर्षणैन्द्रियावाहमिति दर्शयः*). Vrinda
(circa 950 A. D.) notices the preparation of sul-
phide of mercury (*रसासूतचूर्ण*) composed of one
part of sulphur, and half its weight of mer-
cury ; and also of cuprous sulphide (*पर्यटिताम्*).
Chakrapāni (circa 1050 A. D.) mentions the pre-
paration of the black sulphide of mercury, "by
taking equal parts of mercury and sulphur".

The Rasārṇava (circa 1200 A. D.) notices the
colours of metallic flames, probably after Patañjali ;
e. g. copper gives blue flame ; tin, pigeon-
coloured ; lead, pale ; iron, tawny ; blue vitriol,
red. It may be noted that the Rasārṇava regards
mercury as a penta-Bhautic substance.

The Rasaratna-samuchchaya divides the mi-
neral kingdom (Earth-substances, simple and
compound) into the following classes :— (1)
The eight Rasas, mica, pyrites, bitumen, blue vitriol,
calamine, etc. (2) The eight Uparasas
(useful in operations of mercury), sulphur,
red ochre, green vitriol, alum, orpiment, realgar,
collyrium, and medicinal earth, to which may be
added the eight Sādhārana Rasas, sal-ammoniac.
cowrie, cinnabar, rock vermilion, etc. (3) The
gems, diamond, emerald, sapphire, cat's eye, sun-
stone, moon-stone, pearl, etc. (4) The metals,

gold, silver, iron, copper, lead, tin, and the alloys—brass and bell-metal. Other Earth-substances are six salts, three alkalis, mineral earths, and several poisons (cf. vol. I, pp. 32-98).

Chemical compositions and decompositions—metallurgic processes.—In these writings, we frequently come across instances of chemical composition and decomposition, by processes, more or less crude, of calcination, distillation, sublimation, steaming, fixation, etc. (भस्मीकरण चषःपातन, ऊर्ध्वपातन, स्वेदन, सन्धन etc.) e.g. the preparation of perchloride of mercury by taking common salt and mercury (रसकपूर—पारदस्य श्वेत-भस्मीकरणे चन्द्रिकाकारः); of sulphide of mercury (हिङ्गुल) by taking sulphur and mercury; of Sindūra from lead (सिन्दूरं नागसन्धनम्—Amara-kosha sixth century A. D.);—of the medicinal compounds, Svārṇa-sindūra and Rasasindūra, with mercury, sulphur and gold, where gold may have been fancied to influence the resulting compound in some mysterious way, either as a 'dynamic' or as a catalytic;—also the extraction by chemical decomposition of mercury from sulphide of mercury (हिङ्गुल,—vide रसरत्नसमुच्चय); of copper from sulphate of copper (तुल्य, सखक) by heating this substance with one-fourth of its weight of borax (Rasaratna-samuchchya,—cf. Bhāvaprakāsa, तुल्यं

तु ताक्षीपधातु किञ्चित् तावन्नेष तद्वति) ; of zinc (बङ्गान, जसद) from calamine (रसक—Rasārṇava) ; of copper from pyrites (माक्षिक, विमल, etc.—Rasārṇava, (though the golden pyrites were supposed to be a semi-metal of gold, containing some gold along with the essence of copper)—the purifications of mercury by repeated distillation from lead and tin with which it was wont to be adulterated in the market. The various metallurgic processes described are—extraction, purification, killing (formation of oxides, chlorides and oxy-chlorides for the most part), calcination, incineration, powdering, solution, distillation, precipitation, rinsing (or washing), drying, steaming, melting casting, filing, etc. to all which each of the known minerals was successfully subjected by the use of apparatus and reagents and the application of heat in different measures (खरपाक—मध्यमपाक—and स्रद्धपाक),—methods which, if often crude, especially from the absence of independent and isolated mineral acids, were yet in several instances remarkably simple and effective, and which, after all by the use of various Vidas potentially containing mineral acids aqua regia, sulphuric acid, hydrochloric acid, etc.) virtually accomplished the practical ends kept in view. To these were added several special processes for mercury (*e. g.* fixation), bringing up the number of mercurial operations to nineteen.

It may be noted that the mixtures called *Vidas*, which potentially contained dilute mineral acids, were regularly employed not only in killing the metals (forming their oxides and chlorides), but—what is of fundamental importance—for purposes of chemical decomposition of metallic salts, etc. and the extraction and purification of metals.

Organic Compounds.—Organic Compounds are either vegetable or animal substances (खादर जङ्गल सूत). The molasses, the fermented liquors, the saps and juices of plants, fruit acids, vegetable ashes and alkalis together with the tissues of plants are vegetable compounds (पौष्टिक खादर सूत). Honey milk, curd, butter, fat, bile, urine, and other excreta, together with the organs and tissues of animals, are animal substances. Charaka notices vegetable as well as animal oils. The viscous (oily) substances are classed under four heads—butters, oils, fats, and marrows (सर्पिकेल वसा मज्जा लेहो दृढसुविषः). Salt may be either mineral or vegetable salt.

Susruta divides poisons into two classes—Vegetable and animal, but several poisons expressly termed mineral poisons (प्रातुविष) are included in the first class.

All organic substances, whether animal or vegetable, are penta-Bhautic, being compounded

of greater or less proportions of the five Mahā-bhūtas.

Taking the human body Charaka finds that the foetus is composed of sixteen organic substances, viz. four, composing the Sperm-cell which comes from the male; four composing the germ-cell which comes from the female; four added by the transformation of the nutritive material, and finally, four kinds of subtile matter, which together form the vehicle of the conscious principle. As to the four organic substances which compose the sperm-cell, or the other four which compose the germ-cell, it is not clear whether in Charaka's view they are also in their turn compounded of less complex organic substances, or whether their constituent elements are inorganic penta-Bhautic compounds.

The tissues that appear in the course of developments of the foetus are further transformations (higher compounds) of these foetal substances. All the component substances of the body are penta-Bhautic compounds, though sometimes they are assigned to the particular Bhūtas which predominate in their composition, *e.g.* bile to Tejas, lymph, chyle, blood, fat, urine, sweat and other secretions to Ap, and skin, flesh, bones, nails, hair, etc. to Earth.

(यन्मं वायुमिभूम्बव्युषपादवत् ।—गर्भस्य चत्वारि ऽवतुर्विधाणि भूतानि

मातापितृसम्भवाणि आहारजानि आत्मकृतानि चैव et seq. Charaka, S'árirasthana, Chap. II. vide also Charaka, S'árirasthána, Chap. VII. cf. Gaṅgádhara's Jalpakaalpataru. पितृ तृतीयं भूतं शरीरारम्भकतेजःप्रधानपञ्चभूत-
विकारात्मकं तेजःस्वरूपमग्रिमंशम् । कफश्चतुर्थं भूतमापः शरीरारम्भकसीम-
प्रधानपञ्चभूतविकारविशेषः । शरीरं तु पञ्चमहाभूतविकारसमुदायात्मकम् ।
Cf. Charaka S'árirasthána, Chap. IV. मातृजादयोऽपि च स
महाभूतविकाराः ।)

Fœtal Development (after Susruta). The ovum fertilised by the sperm-cell and developing under the influence of animal heat forms successive layers and tissues even as layers of cells and fibres are formed in wood. First are formed seven layers epithelial and dermal (सप्तत्वचः), then follow the several tissues (कलाः), the flesh, the vascular tissue, the fat and marrow, the lymphatic (and glandular) tissue, the intestinal tissues, the biliary and the seminal vessels,—tissues which are regarded by some as modifications of the original dermal layers of the ovum (cf. the layers of the blastoderm and their relation to the tissues in Embryology). The tissues are supposed to be developed successively, one out of another, by chemical action or metabolism (पाक), e. g. chyle is transformed into blood, blood into flesh, flesh into fat, fat into bone, bone into marrow, marrow into sperm-cell. The organs are next formed out of the tissues. The liver, gall-

bladder (क्लोम), spleen and lungs are referred to the blood ; the intestines to the blood, lymph and bile ; the kidneys to the blood and fat ; the testicles to the blood, lymph and fat ; the heart to the blood and lymph ; and the tongue to the lymph, blood and flesh. Vāyu, with the accompaniment of animal heat, impels the 'currents' (कीलानि) in the system ; Vāyu acting on the flesh gives rise to the muscles, and it is Vāyu again, which, with the essence of fat (or marrow), produces the nerves, arteries and tendons. (तस्य खलु यक्रशेषितस्य अभिपच्यमानस्य क्षीरस्यैव सन्तानिकाः सप्तलक्षी भवन्ति ।—कक्षाः खलपि सप्त सन्भवन्ति । यथाहि सारः काष्ठेषु ह्रियमानेषु दृश्यते । तासां प्रथमा मांसधरा । द्वितीया रक्तधरा । तृतीया मेदीधरा । चतुर्थी श्लेष्मधरा । पञ्चमी पुरीषधरा । षष्ठी पित्तधरा । सप्तमी यक्रधरा ।—गर्भस्य यक्रतुण्डोद्गानो शेषितजौ ।—et seq Susruta, S'árirasthána, Chap. IV.—रसाद्रक्तं ततो मांसं मांसान्मेदः प्रजायते । मेदसीऽस्थि ततो मज्जा मज्जः यक्रस्य सन्भवः । S'útrasthána, Chap. XIV.)

The following parts (tissues and organs) in the foetus are in a special sense modifications of the four organic substances contributed by the sperm-cell of the male parent ; hair, nails, teeth, bones, nerves, veins and arteries, tendons and ligaments, and the sperm-cell ; the following, of the substances derived from the mother,—skin, blood

flesh, fat, the heart, liver and spleen, kidneys, stomach, intestines, etc. (Charaka, Sārirāsthāna, Chapter III. याणि खल्वस्य गर्भस्य पितृजानि पितृतः सन्भवतः सन्भवन्ति, तद्वयथा केश-शृङ्गु-गन्ध-लोम-दन्तास्थिशिरा-स्नायु-धमन्वः युक्तमिति पितृजानि । याणि खल्वस्य गर्भस्य मातृजानि याणि च चक्षु मातृतः सन्भवतः सन्भवन्ति—तद्वयथा त्वक् च लोहितश्च मांसश्च मेदश्च इदं च यकृत् च ग्रीवा च हृद्ग्रीवश्च पुरीषाधानं च आमाशयश्च इति मातृजानि ।)

Chemistry of Digestion—The food we eat contains five classes of penta-Bhautic organic compounds. From their radicles or predominant elements, the substances are named Earth-compounds, Ap-compounds, Tejas-compounds, Vāyu-compounds and A'kāsa-compounds. The Earth-compounds supply the hard formed matter of the body, the Tejas-compounds give the animal heat (or the metabolic heat), the Vāyu-compounds are the sources of the motor force in the organism, the Ap-compounds furnish the watery parts of the organic fluids, and the A'kāsa-compounds contribute to the finer etheric essence which is the vehicle of the conscious life. Roughly speaking, the Earth-compounds answer to the nitrogen compounds in the food, the Tejas-compounds to the hydro-carbons (heat-producing) and the Vāyu-compounds to the carbo-hydrates (dynamic). The Ap-compounds are the watery parts of food

and drink. The flesh, for example, is a tissue composed principally of the Earth-compounds, the fat of the Earth and Ap compounds, the bones of Earth Váyu and Tejas compounds. The Tejas compounds predominate in the composition of the blood. For purposes of digestion it is stated that different operations of the metabolic heat (perhaps different digestive fluids are also meant) are required to digest the different substances in the food.

The course of metabolism is described as follows :—The entire alimentary canal is called Mahásrotas (the great channel).

The food goes down the gullet by the action of the biomotor force, the Prána-Váyu.

In the stomach (आनाशय) the food becomes mixed up first with a gelatinous mucus (फेणोभूत कफं) which has a saccharine taste, and then gets acidulated by the further chemical action of a digestive juice (विदाहादकता गतः)—evidently the gastric juice is meant. Then the biomotor force, the Samána Váyu, begins to act and drives down the chyle by means of the Grahani Nádí to the Pittásaya (duodenum), into which bile comes down from the liver, and thence to the small intestines (the आनपक्वाशय). In these, the bile (or rather the digestive substance in the bile as opposed to the colouring element) acts on the chyme, and converts the latter into chyle (रस), which has at first

a Katu taste (pungency). This chyle contains in a decomposed and metamorphosed condition all the penta-Bhautic organic compounds, viz. tissue-producing Earth-compounds, water parts or Ap-compounds, heat-producing Tejas-compounds, force-producing Váyu compounds, and lastly, finer etheric constituents which serve as the vehicle of consciousness. The essence of chyle (सूक्ष्मभाग) from the small intestines is driven by the biomotor force, the Prána Váyu, along a Dhamaní trunk (cf. the thoracic duct) first to the heart (which is a great receptacle of chyle), and thence to the liver (and the spleen), and in the liver, the colouring substance in the bile acts on the essence of chyle, especially on the Tejas substance therein, and imparts to it a red pigment, transforming it into blood. But the grosser part of chyle (स्थूलभाग) proceeds along the Dhamanís, being driven by the biomotor force, the Vyána Váyu, all over the body.

When the blood has been formed, the essence of chyle in the blood, acted on by Váyu (biomotor force) and Mámságni (the flesh-forming metabolic heat), forms the flesh tissue, the Earth-compound of the food substance especially contributing to this tissue. Of the flesh tissue thus formed, the grosser part goes to feed or replenish the flesh tissue all over the body. The finer essence of flesh in the

blood in the chyle, acted on again by Váyu (biomotor current) and the fat-forming metabolic heat (निदोऽग्नि) in the menstruum of lymph (कफं सनाश्रित्य), receives viscosity and whiteness, and produces the fatty tissue, the Earth-compounds and Ap-compounds of the food especially contributing to the product. This fat in the chyle (or blood), or rather the grosser part of it replenishes the fatty tissue of the body, but the finer essence of fat in the flesh in the blood in the chyle, acted on by Váyu (biomotor current) and the marrow-forming metabolic heat, in the menstruum of lymph (क्षेयपातन), becomes hard (or crystalline), and forms bone, the Earth, Váyu and Tejas compounds contributing principally to the product. The essence of the fat fills the hollow channels of the bones, and acted on again by biomotor Váyu and metabolic heat, becomes transformed into the marrow. The marrow is transformed into the semen, which is conveyed down by means of a pair of Dhamanís (ducts) (द्वे युक्तवद्भे), lodged in its receptacles (युक्तधरा—इवचौ) and discharged by means of another pair of ducts (द्वे विसर्गाय). The semen, or rather all the elements in their finer essence, give off Ojas, which returns to the heart, the receptacle of chyle and blood, and again floods the body, and sustains the tissues, thus completing the wheel (or self-return-

ing circle) of metabolism (पारदृष्टिस्तु चक्रवत्. Cf. Charaka and Vāgbhata).

It is to be noted that, throughout, the fluid in the chyle (or blood) acts as the menstruum, though occasionally the lymph, which is itself a derivative from the chyle is added as in the case of the fatty tissue and the marrow ; and that each preceding element or constituent of the body (चातु-शरीरारम्भकधात्) takes up the proper organic compounds from the food-chyle to form the next element or tissue. Throughout also, the chemical changes are due to the metabolic heat which breaks up the compounds and recombines, but the operations and even the vehicles perhaps of this heat are different. For example, these heat-corpuscles in the biliary ducts produce the bile, but the bile secretion is supposed to contain two distinct substances, (1) a digestive fluid in the duodenum (पित्ताग्नय) which acts on the chyme to produce the chyle, (अन्नस्य पक्षुपाचकाख्यं पित्तं) ; and (2) a colouring bile substance in the liver which adds a red pigment to the chyle and transforms it into blood (रक्तकाख्यं पित्तम्). Besides, there are three other biles, of which the aqueous humour in the eye is supposed to be one (चाक्षीचक्षुपित्तम्) helping in the formation of visual images (रूपवाचकम्). This is the view of Dhanvantari and his school, but A'treya holds there is no

evidence that the bile really performs the first (digestive) function, for this can be accounted for by the animal heat arising from the working of the whole bodily machine. There are three different hypotheses regarding the course of metabolism and the successive transformations of the chyle (चौरदधिन्याय-केदारगोकुल्यान्याय खल्लेकपीतन्यायेति त्रिधा चातुर्पोषण-क्रमः—Chakrapāṇi, Bhānumatī, Sūtrasthāna, Chap. 14, S'loka 10; also his commentary on Charaka, Sūtrasthāna, Chap. 28), but my account is based upon the second hypothesis which has the preference of Chakrapāṇi (स्वरसः). It may be added as a curiosity that each element of the body (धातु) under the metabolic heat is supposed to give off a finer essence (सूक्ष्मभाग) which serves as the material of the next succeeding element, and a dross (मल), which forms some of the excreta in the body (including the nails, the hair, etc.), besides retaining its own substance (the gross or main part) which is driven along by the Vāyus (biomotor or vital currents) or by the Srotas to its destination in the body. Some idea of circulation appears to have been entertained, for the heart which receives and then sends down the chyle through the Dhamaṇīs gets it back transformed into blood, and the Ojas also proceeds from the heart and returns to it along with the chyle and blood. (Cf. Vāgbhata—माः इत्स्याः त्रिराः रसावसर्गं चीजः

अभिवर्द्धनः)। पञ्चभूतात्मके देहे आहारः पाचनीयः। विपक्षः पचया सम्यग्गुणान् स्नानमिवर्द्धयेत्। *Susruta, Sūtrasthāna, Chap. 46. Cf. also* वियत्पवनजाताभ्यां वृद्धिमाप्नोति मातुः। आद्येयमेव यदद्रव्यं तेन पित्तमुदीर्यते। *Ibid., Chap. 41.* मौमाप्याग्नेयवायव्याः पक्षीमायः सनाभसाः। पंचाहारगुणान् स्नान् स्नान् पार्थिवादीन् पचन्त्यगु। यथास्वं ते च पुञ्चन्ति पक्का भूतगुणान् पृथक्। पार्थिवाः पार्थिवानेव शेषाः शेषाश्च देहान्। अतिरिक्ता गुणा रक्ते बद्धेर्मांसि तु पार्थिवाः। मेदस्सर्पा भुवश्चास्थि पृथिव्यनिलतेजसाम्। *Charaka, quoted by Dalvana.* चादौ बद्धरसमप्यन्नं मधुरीभूतनीरयेत्, फेणीभूतं कफं यातं विदाह्यादन्नात् ततः। वायुना समानाख्येन यद्वशीमभिनीयते। षष्ठौ पित्तधरा नाम या कला परिकीर्तिता। आमपक्वाशयान्तःस्था यद्वशी साऽभिधीयते। अन्यविष्टानमन्नस्य यद्वशाद्वयद्वशी मता। सुक्तनामाशये बद्धा सा विपाथ्य नयत्यधः। वल्लदत्यवला त्वन्नमानमेव विमुचति।...अन्नस्य पक्त्वा पित्तान् पाचकाख्यं पुरेरितम्। दोषघातु-रुणादीनामुन्नेत्या-वेयश्रासमन्।...तेजोरसानां सर्वेषामम्बुजानां यदुच्यते। पित्तीक्ष्णा सरानेष रसो रक्तत्वमृच्छति। वायुप्रितेजसा युक्तं रक्तं मांस-त्वमृच्छति। श्लेष्माद्यं च समाश्रित्य मांसं वाय्वग्निर्युतम्, स्थिरतां प्राप्य शीलां च मेदो देहेऽभिजायते। पृथिव्यनिलवादीनां सञ्जातः श्लेष्मावतः। स्मरत्वं प्रकरोत्यस्य जायतेऽस्थि ततो कृषाम्। करोति तत्र सौमिथ्यमस्यां मध्ये समीरयः। मेदसा तानि पूर्वमेव वेष्टी मज्जा ततः कृतः। तन्मान्मज्जश्च यः वेष्टः शुक्लं संजायते ततः।

Charaka—Dridhabala Samhitá, quoted by Aruna in his commentary on Vágbhata. यथा कीदारनिषक्तं कुल्याजलं प्रव्यासन्नां कीदारोमाप्रावयति, तथा रस एव प्रथमं रक्तं प्रावयति। तच्च रक्तस्थान-सम्बन्धात् रक्तसादृश्यं रक्तव्यपदेशं च अनुभवति। रक्तं च रक्तसमानेन स्त्रीकिनांशेन अन्नं पोषयति। ततो रक्तमाप्राप्य नांसमाप्रातयति, एवमुत्तरोत्तरधातून् रस एव प्रावयति। (Chakra-datta, Bhānumatī). This passage shows that the 'venous blood' was conceived to be chyle-essence mixed with blood, and that the circulation of the chyle so far as it was held to contribute its quota to the constituent elements and tissues of the body was really supposed to be identical with the circulation of the blood (ततो रक्तमाप्राप्य नांसमाप्रातयति). This will be abundantly clear from the following account of the course of the chyle and the blood :—

ततः सारभूतस्याहाररसस्य द्वौ भागौ भवतः। स्थूलः सूक्ष्मः... ततः सूक्ष्मो भागः प्राणवायुना प्रेरितो धमनीमार्गेण शरीरारम्भकस्य रक्तस्य स्थानं यज्जत् प्रोद्भूतं गत्वा तेन सह मिलितो भवति। ततः प्राक्तन-रक्तधातो एव तिष्ठति।.....ततः सारभूतस्य आहार-रसस्य द्वौ भागौ भवतः। स्थूलः सूक्ष्मः। स्थूलो भागो रंज-काख्येन पित्तेन रक्तीकृतः शरीरारम्भक रक्तं पोषयन् व्यान-वायुना प्रेरितो धमनीभिः संचरन् सकलशरीरगतानि रुधिराणि पुष्पाति। ततः सूक्ष्मो भागः व्यानवायुना प्रेरितो धमनीभिः शिराभिश्च शरीरारम्भकाणि नांसानि याति। et seq.

This finer essence of chyle which nourishes the flesh must also be carried in the blood, on the 'irrigation channel' hypothesis (वेदारीकुल्यानाय). (For diagrams of the central circulation and the sympathico-spinal nervous system, *vide* my Paper on Hindu Anatomy and Physiology. The mechanism of life and the inheritance of specific and other congenital characters are also dealt with in the same paper).

Formation of molecular qualities in chemical compounds :—The Charaka school, which, we have seen, was an offshoot of the Sāṅkhya (cf. Charaka, Vimānasthāna, Chap. 8, यथा वादित्वः प्रकाशकः तथा सांख्यवचनं प्रकाशकमिति) supplemented the above account of inorganic and organic compounds with a characteristically Sāṅkhya explanation of the formation of molecular qualities by chemical combination. In Charaka's view, the colours, tastes, etc. of the molecules of chemical compounds result from the collocation in unequal proportion and unstable equilibrium of the different forces latent in the atoms (Paramāṇus) themselves. (एवमेतेषां रसानां षट्समुपपन्नं गूणातिरिक्त-विशेषात् सङ्गमूतानां। मूतानामिव स्वावरणकमानां नामावर्णाकृति-विशेषाः। Charaka.)

Chemistry of colours.—As an interesting example of the way in which a follower of Charaka would account for the colours of chemical compounds, I may note the explanation given by the late Gaṅgādhara Kavirāja Kaviratna in the *Jalpakaalpataru*, a commentary on the *Charaka-Samhitā*, published at Calcutta in 1869, premising that the Kaviraja's view is pure and genuine Charaka doctrine. Gaṅgādhara begins with a simple statement. The qualities of the atom, he writes, tend to produce similar qualities in the molecule. A molecular quality is therefore the result of the conjunction or opposition, as the case may be, of the atomic tendencies. When, for example, the five Bhūtas combine to produce an organic compound (the human body), Tejas, Ap and Earth tend to produce red, white and black respectively, but in the body (compound substance) the yellow colour may happen to be produced as the result of these tendencies in that particular proportion and collocation. The point to note here is that the molecule forms a fresh collocation, *redistributes the Mass and Energy*, and sets up new forces in the system which coming into play modify the potencies (or tendencies) in the component atoms and thus determine the resultant. This is elaborated into a curious but complete theory of the colours of chemical compounds.

The colours (and other qualities) of a simple substance (an isomeric mode of any Bhúta) are the result of the potencies lodged in that particular collocation of Mass, Energy and Essence. Now when two such substances unite, their colours etc. tend to be produced, but the combination brings on a fresh distribution of Energy, Mass and Essence, and the forces thus set free may powerfully modify or even extinguish the separate tendencies or potencies of the component simple substances. For example, when we prepare a collyrium by mixing equal parts of sulphur and mercury (the black sulphide of mercury), we find the resulting compound black. To explain this, it has to be remembered that each of the substances (sulphur and mercury), contains Sattva (Essence), Rajas (Energy) and Tamas (Mass) in different proportions, and that predominant Tamas (Inertia, Mass) always produces black, predominant Sattva (Essence) white and predominant Rajas (Energy) red. Now in the black sulphide of mercury, the white of the mercury tends to produce white and the yellow of the sulphur yellow ; and if these tendencies were not obstructed, the result would be a mixed colour. But, in the particular collocation in question, the Tamas of the mercury becomes intensive (तीव्र), and the black of the now intensive Tamas

extinguishes the white in the uncompounded mercury, which was due to prevailing Sattva, as well as the yellow of the uncompounded sulphur, which was due to the combined operation of white-producing Sattva and red-producing Rajas. Again, when, with proper apparatus and by the application of heat, we combine mercury and sulphur to produce the red sulphide of mercury, the resulting colour is explained by the fact that in this new collocation the Rajas (Energy)—probably of the mercury, though Gaṅgādhara does not specify—becomes intensive (तीव्र), and extinguishing both the white-producing Sattva of the mercury and the yellow-producing Sattva-Rajas of the sulphur, imparts a red colour to the compound. In these cases, as also in the formation of red by mixing powdered termeric with lime, *i.e.*, whenever a new colour is produced in the compound it is to be explained by the dominance of Tamas, Rajas or Sattva, or their combinations, and the extinction of the uncompounded tendencies (or potencies) by the forces set free in the new collocation. But there are other cases where the colour of the compound is a mixed colour resulting from the colours of the combining substances, *e.g.*, when sulphide of mercury and calcined tin are mixed, the resulting colour is evidently a mixed one (Pātala, pink), which is

easily explained by the colours of the component elements (the red of the sulphide of mercury and the white of the calcined tin). In the same way, in a mechanical aggregate, as in a piece of cloth, the colour is white, where the threads are white.

(तत्कार्यान्मो प्रथिव्यादिद्रव्यावस्थागुणा गन्धादयः खलु स्वस्व-
जातीयं गन्धविशेषादिकं आरभमाणाः यदारभ्यमाणं स्वस्वविजातीयं
कार्यं स्वारम्भकं कारणञ्च अहङ्कारादित्यं गुणाग्रं उभयथा
कुवचित् इत्वा कुवचित् न इत्वा स्वजातीयं गुणविशेषं आरभन्ते ।
यथा पारदगन्धकयोः संयोगे कज्जलीभूतद्रव्ये पारदस्थः शुक्लः शुक्ल-
विशेषं आरभमाणः गन्धकस्थपौतः पौतमारभमाणः पारदस्थतोष्णेन
तैश्च्यमारभमाणेन विरोधिना बध्यते । सर्वत्रैव शीतलं सत्त्वगुणयोगिकं
तमोगुणयोगिकेन तैश्च्येन विरोधिना बध्यते । गन्धकस्थपौतस्यै च
लोहितशुक्लौ रजःसत्त्वयोगिकौ बध्यते । तयोः शुक्ललोहितवधे तैश्च्य-
समानयोगिः कृष्णः अभिव्यज्यते । इति पारदगन्धकोभयात्मके कार्ये
श्वेतपौतमेलनेन सम्भाव्यं कार्यं यदवधे तत् तीक्ष्णगुणेन बध्यते,
तत्कारणं शुक्ललोहितं इत्वा । एवं हिङ्गुले पारदगन्धकाभ्यामारभ्यमाणे
यन्मिश्रणे वाङ्मना पच्यमाने रजोबहुलयोगिकेन तीक्ष्णेन सत्त्वतमो-
योगिकौ शुक्लकृष्णौ बध्येत । पारदस्थशुक्लगन्धकस्थपौतमेलनेन सम्भाव्यं
कार्यं वधे च बध्यते । रजोयोगिकलोहित्यं च अभिव्यज्यते इति ।
एवं हरिद्राचूर्णसंयोगेऽपि लौहित्यं अभिव्यज्यते चूर्णस्थतेऽप्येन हरिद्रास्य
शुक्लकृष्णवधे । अथ अवधे यथा—हिङ्गुलवक्त्रभक्तसंयोगे श्वेतलोहित-
वर्धमेव उभयात्मकं भवति पाटलवर्णं, न च तत्र हिङ्गुलस्य

लोहितं वक्रमक्षयं शीतं च केनापि वध्यते। एवं शुक्लस्य-
निर्मितपटस्य शीतमेव।) (Jalpakaalpataru, Sūtrasthāna-
of Charaka, pp. 198-200; edition published
by Bhubanachandra Basak, Calcutta, Samvāda-
ratnākara Press, Samvat 1925.) This is quite
in a line with Charaka's explanation of the tastes
of chemical compounds which has been already
noticed.

Parināma-vāda versus Aśrambha-vāda : Charaka's
view of the formation of a new quality or a new
substance is based on the Sāṅkhya teaching as to
the conservation and transformation of Energy,
and brings chemical synthesis in a line with
evolutionary change (परिणाम). On this view, a
new substance may arise by spontaneous or isome-
ric change, i.e., by the inter-play of Energies within
the system of any given substance, in the absence
of any action from without. New qualities like
new substances are only readjustments of the
old, and continual changes are going on by
spontaneous disintegration and recombination.
Opposed to this evolitional view of chemical
synthesis is the Nyāya-Vaiśeṣika doctrine of
Aśrambha-vāda, according to which no change of
substance or quality, no effect, in short, can take

place except by the action of one component element (substance or quality) on another. A binary molecule, for example, cannot possess any 'specific quality' (विशिष्टगुण) of a kind not represented in each of the two component atoms. In the cosmic process, no atom can exist free and uncombined with another atom, and every 'specific quality' in a substance can be ultimately analysed into the union of two 'specific qualities' *of the same class* in two ultimate particles which cannot be further divided. A single colour, smell or taste in a single particle, until it can link itself on to another specific quality *of its own class* in a second particle, cannot characterise any substance formed by the union of these particles as material causes. Hence an Earth-atom cannot unite with an Ap-atom, to form a new substance of which both the particles must be equally regarded as material causes. At any rate, such a compound, if effected, would be smell-less, as of the two constituent atoms, only one, viz. the Earth-atom, possesses smell. A compound of Earth and Vāyu would be smell-less, colourless and tasteless, and so on. The Nyāya-Vaisesika does not deny that there may be compounds of different Bhūtas, nor does it deny the causal operation of specific qualities as efficient or energising (dynamic) causes (उपपत्त्यकारण, निमित्तकारण) but it refuses to place

these compounds on the same footing as compounds of isomeric modes of the same Bhúta; and it accepts the 'material' causality, in such cases of only one of the Bhútas, regarding the others as 'co-efficients' (निमित्तकारण).

The earlier Sāṅkhyas including the medical schools of ancient India brushed all this aside as a distinction without a difference. The Vedantists, as we shall presently see, flouted this doctrine of A'rambha-vāda. The Jainas, in opposing this Vaiseshika view of atomic combination, hit upon a solution of the problem of chemical affinity. Others again, found out a *via media*. They held, as we learn from the reports of Udyotakara in the Nyāya-vārtika, and of Vāchaspati Misra in the Tātparyyaśikā, that a molecule of the structure EA (one atom of Earth and one of Ap) would exhibit some variety of colour and taste resulting from the joint action of the atoms and of their several colours and tastes. But as in the combination EA only the Earth-atom possesses smell, and the Ap-atom is smell-less, and as moreover no quality in a compound substance can result except from the joint action of the similar (potential) qualities of at least two component elements, it follows that a molecule of the structure EA would not manifest the energy of smell potentially contained in the Earth-atom.

Hence, admitting the combination EA for a smell-less compound, the upholders of this view would suppose a molecule of the type E_2A (i. e. two atoms of Earth and one of Ap) to explain any bi-Bhautic compound of Earth and Ap (like the plant saps and fruit juices) which exhibits smell in addition to the peculiarities of colour and taste. (Cf. Vāchaspati's comment on Udyotakara's refutation of this view :—

अयमभिसन्धिः । पृथिव्याप्यपरमाणु तावन्नैकं द्वाणुकमारम्भमु-
नईतः तयोः रूपरसस्पर्शवत्त्वेन तदारम्भसम्भवे अपि गन्धवत्त्वा-
भावप्रसङ्गात् । एवं पार्थिवाणु समवेतस्य गन्धस्य एकत्वेन अनारम्भ-
कत्वात् नापि पार्थिवपरमाणुद्वयं एकस्य पाथसीयपरमाणुः इति
अणुनामारम्भकत्वे गन्धवत्त्वोपपत्तिः इति साम्प्रतं । परमाणूनां बहूनां
अनारम्भकत्वात् । तथाहि त्रयः परमाणवः न कार्यमारभन्ते ।)

Measures of Time and Space. Size of atoms.

The Siddhānta-S'īromani gives the following measures of Time :—

30 Kshanas = 1 day, 2 Ghatikās = 1 Kshana,
30 Kalās = 1 Ghatika, 30 Kāshthās = 1 Kalā,
18 Nimeshas = 1 Kāshthā, 30 Tatparas =
1 Nimesha, and 100 Trutis = 1 Tatpara.

This makes a Truti of time equal to $\frac{1}{100}$ of a second, which is nearly the measure of

the Paramānu of time; as given in the Vishnu-purāna (vide Bhāskara's Siddhānta-Sīromani—कालमानाध्यायः) ।

The above measures were in use among the astronomers, but the physicists computed according to the following table given both in Udayana's Kiranāvali and S'rilhara's Nyāyakandalī :- 30 Muhūrtas = 1 day (24 hours), 30 Kalās = 1 Muhūrta, 30 Kūshthās = 1 Kalā, 18 Nimeshas = 1 Kūshthā, 2 Lavas = 1 Nimesha, 2 Kshanas = 1 Lava.

अणुद्वयं लवः क्षीप्तौ निमेषस्तु लवद्वयम् ।

अष्टादशनिमेषास्तु काष्ठा विशतु ताः कला ।

विंशत्कला रुद्धः स्यात् विंशद्रात्रादृशी च तः ।

(Udayana, Kiranāvali).

This makes 1 Kshana of the Nyaya-Vaisesika equal to $\frac{2}{3}$ of a second. The Nyāya assumes that the unit of physical change (or the time occupied by any single antecedent step in a causal series before the succeeding step is ushered in) is equal to a Kshana (or $\frac{2}{3}$ of a second). The astronomers were familiar with far smaller measures of time. The astronomical Truti of time measures about the thirty-four-thousandth part of a second. This is of special value in determining the exact character of Bhāskara's claim to be regarded as the precursor of Newton in the discovery of the principle of the Differential Cal-

culus, as well as in its application to astronomical problems and computations. This claim, as I proceed to show, is absolutely established; it is indeed far stronger than Archimedes's to the conception of a rudimentary process of Integration. Bháskara in computing the "instantaneous motion" (तात्कालिकी गति) of a planet compares its *successive* positions, and regards its motion as constant during the interval (which of course cannot be greater than a Truti of time, though it may be indefinitely less). This *tátkálíka* motion is no other than the differentia of the planet's longitude, and Bápudeva S'ástrí claims that both the conception of the instantaneous motion and *the method of determining it* plainly show that Bháskara was acquainted with the principle of the Differential Calculus. On the data before him, Mr. Spottiswoode remarks that Bápudeva S'ástrí "overstates the case." Bháskara "makes no allusion to one of the most essential features of the Differential Calculus, *viz.*, the infinitesimal magnitude of the intervals of time and space therein employed. Nor indeed is anything specifically said about the fact that the method is an approximate one." "With all these reservations" Mr. Spottiswoode continues, "it must be admitted that the formula he establishes and the method of establishing it

bear a strong analogy to the corresponding process in modern mathematical astronomy" (*viz.*, the determination of the differential of the planet's longitude,—by no means the first step in transcendental analysis or in its application to astronomy). And Mr. Spottiswoode concludes by stating that mathematicians in Europe will be surprised to learn of the existence of such a process in the age of Bhāskara (*circa* 1150 A. D. —born 1114 A. D.). Mr. Spottiswoode's second objection that Bhāskara does not specifically state that the method of the Calculus is only approximative cannot be taken seriously. The conception of limit and the computation of errors came late in the history of the Calculuses of Fluxions and Infinitesimals. For the rest, Bhāskara introduces his computation expressly as a "correction" of Brahmagupta's rough simplification. The first objection (*viz.*, that Bhāskara makes no allusion to the infinitesimal magnitude of the intervals of space and time employed) would be more to the point, if it were well founded. But it is not, and Mr. Spottiswoode's error was due to the insufficiency of the data supplied to him. As a matter of fact, even Bhāskara's unit, the *Truti* of time (or *Paramānu*), is exceedingly small as the very name implies, being about one thirty-four-thousandth of a second of time. And in the passage in which Bhāskara describes the process, he distinguishes

between: Sthūla-gati and Sūkshma-gati (velocity roughly measured, and measured accurately *ie.*, by reference to indefinitely small quantities, for Sūkshma, as we have seen, has always a reference to the Anu, the indefinitely small). Indeed he expressly mentions that the Sthūla-gati takes only Sthūla-kāla (finite time) into consideration, and that the determination of the Tātkālikī Gati (Sūkshma-gati) must have reference to the moment (प्रतिक्षणम्), which is an indefinitely small quantity of time being of course smaller than his unit, the Truti. (Cf. इयं किल स्थूला गतिः यद्य तूष्णा तात्कालिकी कथ्यते.....यदा चासन्नक्षिप्यन्तस्तदा तात्कालिक्या गत्या तद्विषयाद्यनं कर्तुं युज्यते । तथा समीपचालनञ्च । यदा तु दूरतरक्षिप्यन्तः दूरचालनं वा चन्द्रस्य तदा चाद्यया स्थूलया कर्तुं युज्यतेः स्थूलकालत्वात् । यतश्चन्द्रगतिः . नहत्वात् प्रतिक्षणं समा न भवति यतस्तदर्थं अयं विशेषोऽभिहितः ;—nothing can be clearer than this conception of 'momentary' motion.—Bhāskara, Siddhānta-S'iromani, Ganitādhyāya, Gatisphutīprakaraṇa : cf. also प्रतिक्षणं सा न समा नहत्ततः, *ibid.*, cf. also Golādhyāya, Tātkālikī-karana-vāsanā-prakarana, where Bhāskara points out that the mode of computing adopted by the A'chārya (Brahmagupta) is a rough simplification. The computation of relative motion and the idea of resolved components of motion were of course familiar to

the astronomers.—(Cf. एवं सत्याचार्येण लावणार्थं रश्मि-
सम्बन्धिनी गतिकला चर्कप्रविष्टाः। *ibid.*) I may add *en*
passant that Bhāskara's formula for the computation
of a table of Sines also implies his use of the
principle of the Differential Calculus.

Measures of weight and capacity. The Amara-
kosha mentions measures of three kinds—weight,
length and capacity (मानं तुलाऽङ्गुलिप्रस्थः).

The *Krishnala* (Guñjá, Raktiká, the black and
red berry of the Shrub *Abrus Precatorius*) was
employed as a natural measure of weight. 80
Krishnala berries on the average weigh 105 grains
Troy, and this must be taken as the basis of our
computation, though in current practice 80 *Krish-*
nalas are taken to be equivalent to 210 grains.
One *Krishnala* was supposed to weigh as much as
3 medium-sized barley seeds (मध्यषप), one of
the latter as much as 6 white mustard seeds
(गौरसर्षप), one white mustard as much as 3 Ráji
mustard seeds (राजिसर्षप), one of these seeds as much
as 3 *Likshas*, and one *Liksha* as much as 8 *Rajas*
or *Trasarekus*.

We now come to conventional measures. One
gold *Máshá* was the weight of 5 *Krishnalas* of
gold, 1 *Suvarna* or *Tolá* weighed as much as 16
Máshás, and one *Pala* as much as 4 *Suvarnas* or
Tolás. A *Pala* of gold therefore weighs 320 *Krish-*
nalas (Mann, Chap. VIII, Vishnu, Chap. IV, and
Yājñavalkya, Chap. I).

A Máshá of gold therefore would weigh $6\frac{2}{3}$ grains ; a Tolá, 105 grains (in current practice it weighs nearly double as I have stated) ; and a Pala, 420 grains Troy.

The measures for silver were the following :—
1 Silver Máshá = 2 Krishnalas, 1 Dharana = 16 Silver Máshás and 1 Pala = 10 Dharanas. A Pala of silver would therefore weigh 320 Krishnalas. In other words, the Pala was a fixed measure of weight, and was equal to about 420 grains Troy, or double this, if we take the Krishnala of current practice.

A Pala, which equals 320 Krishnalas, was subdivided by 4, 16 and 5 successively for gold, and by 10, 16 and 2 successively for silver. A Suvarna (or Tolá) of gold corresponds roughly to a Dharana of silver, and a gold Máshá to a silver Máshá, but the sizes (or volumes) are not the same, and we must not therefore conclude that gold was supposed to be heavier than silver in the proportion of 5 to 2.

We find that 1296 Trasarenu equal 1 Krishnala. A Trasarenu, as a measure of weight, therefore, is the equivalent of $\frac{7}{1296}$ of a grain Troy or double this according to current measures.

But the Trasarenu of physics is a different conception. It stands for the *minimum visible*, i.e., as the physicists define it, that which is *just discernible* as a glancing particle in the slan-

ting beams of the morning (or afternoon) sun, coming into dark room through a chink or orifice of a window. This is a measure of size (or rather stimulus limen).

Measures of Capacity. Here the standard was furnished by the Kudava (कुडावा), a vessel described as 3 Angulis long, 3 Angulis broad, and $1\frac{1}{2}$ Anguli deep,—with a cubical capacity of $13\frac{1}{2}$ cubical Angulis. 4 Kudavas=1 Prastha, 4 Prasthas=1 Adhaka, 4 Adhakas=1 Drona, and 4 dronas=1 Khári or Bhára.

24 Angulis make 1 Hasta, cubit, which may be taken to be 18 or 19 inches. A Kudava was divided into 4 Palas, and there can be no doubt that originally water of the weight of 4 Palas was found to be actually contained in a vessel of the cubical capacity of a Kudava. If we take the ancient cubit to have been 19 inches, the Kudava would contain nearly 4 Palas of distilled water at 30 Centigrade. On a cubit of 18 inches, the Kudava would contain about $3\frac{2}{3}$ Palas.

The Kudava in current medical practice is supposed to represent a cubical vessel, each side being 4 Angulis. This would give a capacity of 27 cubic inches, if we take the modern cubit of 18 inches. The Kavirájas take a Kudava to contain 8 Palas of water, and as 1 Pala=320 Krishnalas, and 80 Krishnalas are now taken to be equal to 210 grains Troy, a vessel of a capacity

of 27 cubic inches is accordingly supposed to contain about 6720 grains Troy,—which is not very wide of the mark, being about 1·3 per cent short for distilled water at 86° Fahrenheit or 30° centigrade.

Size of the *minimum visibile* ; size of an atom.

The supposed thickness of the just discernible mote in the sunbeam called a Paramānu in Technology, S'ilpa-sāstra, (and a Trasarenu in Natural Philosophy , follows directly from Varāhamihira's table :—8 Paramānus make 1 Rajas (or Ratharenu,—cp. the Mānasāra), 8 Rajas make 1 Bālāgra (filament of hair), 8 Bālāgras make 1 Likshā, 8 Likshās make 1 Yūkā, 8 Yūkās make 1 Yava, 8 Yavas (the Mānasāra has 4) make 1 Anguli (superior), 24 Angulis make 1 Hasta (cubit, lesser cubit, 18 inches). The thickness of the *minimum visibile* (the finest perceptible mote in the slanting sunbeam) is therefore taken to be $3 \cdot 2^{-20}$ or $\frac{3}{1048576}$ of an inch. The volume of a spherical Trasarenu (or Paramānu of the S'ilpa sastra) would therefore be $\frac{4}{3} \cdot \pi \cdot 3^3 \cdot 2^{-63}$ of a cubic inch. It may be here noted that such a Trasarenu is supposed in the medical schools to contain 30 chemical atoms (Paramanus of Natural Philosophy) according to one estimate, or 60 according to another. The size of an atom must then have been conceived to be less than $\pi \cdot 3 \cdot 5^{-1} \cdot 2^{-62}$ of a cubic inch.

परमाणुरजीवालायल्लिच्छट्टकं यदीदृशं चेति अष्टगुणानि यदीतरम् अत्र

मेकं भवति संख्या—Varāhamihira, *Vrihatsamhitā*, chap. 57, S'loka 2—जात्यान्तरगते भानौ यद्व्युत्तरं दृश्यं रजोवाति वक्ष्यात् परमाणुं प्रथमं तद्धि प्रमाणाणाम्। *ibid.*, S'loka I,—Cf. Utpala, तत्परमाणुं नाम प्रमाणं जानीयात्। प्रमाणाणां सर्वेषां तत् प्रथममाद्यं प्रमाणं परमाणुसंज्ञम्। Cf. also, वसरेण्यस्तु विज्ञेयः (विज्ञता परमाणुभिः)।

The magnitude of a Paramānu is called *Parimāndalya* (परिमाण्डल्य) in the *Nyāya-Vaisesika*, the name suggesting that the Paramānus were conceived to be spherical in shape. The *Nyāya-Vaisesika* calls a Paramānu a mere point without any dimensions, but in the *Sāṅkhya-Pātañjala*, a Paramānu, though indefinitely small, had still dimensions, being divisible into Tanmātras, which were themselves integrations of Bhūtādi. The diameter of a spherical Paramānu must have been conceived to be less than 3.2^{-20} of an inch (*i.e.* less than the conventional Paramānu with which linear measures begin), and the volume of a Paramānu would therefore, in accordance with Bhāskara's formula, be smaller than $\frac{4}{3}\pi.3^3.2^{-63}$ or $\pi.3^2.2^{-61}$ of a cubic inch where $\pi = \frac{3}{1}\frac{2}{2}\frac{7}{6}$. The Tanmātras were conceived as smaller still.

That these were conventional measures arbitrarily assumed goes without question, for, of course, the Hindus had no physical data for a mathematical calculation of these minute quantities. A Bālāgra (hair-tip, or finest filament of hair), for example, is taken to be 3.2^{-14} of an inch

thick, i.e. less than one five-thousandth fraction of an inch in thickness ; and a fibril of the networks of Dhamaní or Nádí (nerve) that supply the pores of the skin (papillæ ? सुक्ष्माणि रीमकूपप्रतिबद्धानि, Susruta) was supposed to be about a thousandth part of the finest hair in thickness, or $\frac{1}{125}$ of the 'minimum visible', and therefore about $3 \cdot 10^{-32-14}$ of an inch thick (cf. सूक्ष्माङ्गीप्रचारतः रीमः सङ्ख्यमात्रेण तुल्यासु प्रचरति, Pañchadasí), but it is evident that these measures were arbitrarily fixed upon, instead of being arrived at by calculation or actual measurement. Indeed, Charaka expressly states that the number of Sírás and Dhamanís in the body (three million fifty-six thousand nine hundred) is only a conjectural estimate अनिर्दृश्यमतः परं तर्कमेव—S'árírasthána, Chap. VII).

My account of the chemistry of the Sāṅkhya-Pātañjala, and of the affiliated Yoga and medical schools, has anticipated in several points the views of the Vedānta and the Nyāya-Vaiśeṣika. The chemical facts, processes and apparatus are indeed common to all the schools. In the following account of the chemistry of the schools other than the Sāṅkhya-Pātañjala, I will confine myself to the theory of the subject, and even of this I will attempt only the briefest outline.

The Vedāntic view :—

The Vedāntists believe Māyā to be the 'material cause' (उपादानकारण) of the world. The power

of Māyā is the power to realise the unreal—to impart practical Reality or mediate existence to that which does not and cannot possess absolute Reality or self-existence. Māyā is at once real and unreal, while the Brahma (Self) is absolute Reality, absolute Intelligence and absolute Bliss. The world evolves out of Māyā (मायापरिणाम) so that Māyā in the Vedānta replaces the Prakṛiti of the Sāṅkhya. But Māyā, and by implication the world, originate out of Brahma, not by a process of evolution (परिणाम), but of Vivarta (self-alienation). The self-alienation of the Absolute, acting through Māyā, produces in the beginning A'kāśa, one, infinite, ubiquitous, imponderable, inert and all pervasive. The world thus begun goes on evolving, in increasing complexity. The other Sūkṣhma Bhūtas, classes of subtile matter, evolve from A'kāśa, in an ascending linear order,—A'kāśa giving off Vāyu, Vāyu giving off Tejas, Tejas giving off Ap, and Ap giving off Earth. A'kāśa, one, infinite, all-pervasive, has the capacity of sound. Vāyu, subtile gaseous matter, emanates from the universal A'kāśa and is instinct with the potential of mechanical energy (impact, pressure). ईरण, प्रणामित्व, बहन्, व्यूहन,—वायोश्च सर्व्व-चेटाहेतुत्वेन सञ्जायमानाभूतत्वाद्—Vidvanmanorāñjinī). Tejas, subtile radiant matter, emanates from Vāyu, and contains in potentia the energy of light and heat. Ap, subtile viscous matter, is the

transformation of Tejas, and is instinct with the energy that stimulates the nerve of taste, and lastly, Earth, subtile hard matter, which is the transformation of Ap, possesses the latent energy of smell.

But the subtile rudiments of matter must be compounded in various ways, to give rise to the gross constituent matter of the world. These forms of gross matter are called Mahábhútas. There are five kinds of Mahábhúta (gross matter corresponding to the five Sūkshma Bhútas (subtile matter, and the process by which a Mahábhúta is produced from the Sūkshma Bhútas is called Pañchīkarana (quintuplication). All the five Sūkshma Bhútas are present as ingredients, though in different proportions, in each Mahábhúta.

The Mahábhúta Earth, gross earth-matter, is composed of four parts of subtile earth-matter, and one part each of the other forms of subtile matter. The Mahábhúta Váyu is composed of four parts of subtile gaseous matter and one part each of the other forms of subtile matter. And similarly with other Mahábhútas.

Hence if ak, v, t, ap, e, represent the five forms of subtile matter (A'kása, Váyu, Tejas. Ap and Earth), and AK, V, T, AP, E, stand for the corresponding Mahábhútas, we may represent the constitution of the Mahábhútas as follows :—

$AK = ak_4 \cdot (v_1 \cdot t_1 \cdot ap_1 \cdot e_1)$, ak_4 being the radicle.

$V = v_4 \cdot (ak_1 \cdot t_1 \cdot ap_1 \cdot e_1)$, v_4 being the radicle.

$T = t_4 \cdot (ak_1 \cdot v_1 \cdot ap_1 \cdot e_1)$, t_4 being the radicle.

$AP = ap_4 \cdot (ak_1 \cdot v_1 \cdot t_1 \cdot e_1)$, ap_4 being the radicle.

$E = e_4 \cdot (ak_1 \cdot v_1 \cdot t_1 \cdot ap_1)$, e_4 being the radicle.

In forms of gross or compounded matter, the potential energies (or qualities) become actualised. The Mahābhūta Akāśa manifests sound; Vāyu, sound and mechanical energy; Tejas, sound, mechanical energy and heat-light; Ap, the energy of the taste-stimulus in addition; and finally Earth the energy of the smell-stimulus added to the foregoing.

The Pañchadaśī characterises the different Mahābhūtas by their typical sounds; *e.g.*, Akāśa by the echo (hollow booming sound); Vāyu (air) by a sibilant sound, hissing, susurration (imitative symbol, Visi); Tejas (fire) by a puffing (or roaring) sound (imitative symbol, Bhugubhugu); Ap (water) by a liquid sound (imitative symbol Culu Culu, gurgle, splash-splash, glut-glut); and finally Earth by a splitting or rattling sound, a crack or a thud (symbol, kad-kada)—Chap. II. Bhūtavi-veka, S'loka 3, Pañchadaśī, cf. also Jayanta, Mañjarī.)

Others hold that Akāśa, Ether, never enters as a component part, and is always one and indivisible. In this view, the four Mahābhūtas—Vāyu, Tejas, Ap and Earth alone are supposed to be com-

pounded, and by a process which may be called quaternion (cf. the Neo-Platonist quaternion) :—

$$V = v_3 (t_1 . ap_1 . e_1)$$

$$T = t_3 (v_1 . ap_1 . e_1)$$

$$AP = ap_3 (v_1 . t_1 . e_1)$$

$$E = e_3 (v_1 . t_1 . ap_1)$$

These compound forms, as before, are supposed to exercise their specific energies actively. Others again hold that the Mahábhútas—Tejas, Ap and Earth alone are compounded by a process named Trivrit-karana (triplication). Thus $T = t_2 (ap_1 . e_1)$, $AP = ap_2 (t_1 . e_1)$, $E = e_2 (t_1 . ap_1)$.

The Sūkshma-bhútas are forms of homogeneous and continuous matter, without any atomicity of structure ; the Mahábhútas are composite ; but even these are regarded as continuous, and without any atomic structure. The Vedánta speaks of Anu (Paramánu) not as an ultimate indivisible discrete constituent of matter, but as the smallest conceivable quantum or measure of matter. In the Sāṅkhya doctrine, the atomic structure is ordinarily accepted. The Gunas are supposed to be परिच्छिन्न and अक्षर bounded and indefinitely small in size (except the Gunas giving rise to A'kāśa and Manas which are unlimited अपरिच्छिन्न) ; and hence the Tanmátras and Paramánu must be conceived to have a discrete structure.

As I have already noted in my account of the genesis of Tanmátras and Paramánu, various

schools of Vedántists (*e.g.* the Rámánujists and the followers of Nimbárka) combined, in the orthodox fashion of the Smritis and the Puráṇas, the Vedántic theosophy with the Sāṅkhya cosmology especially as regards Prakṛiti and the order of creation and dissolution. For example, the Vedánta-kaustubhaprabhá, fortifying itself with texts from the Vishṇu Purāṇa and the Subala and Gopála Upanishadas, contends that at the cosmic dissolution (Pralaya), each Mahábhúta merges into the one that preceded it in the order of creation by first disintegrating into its own proper Tanmátric form (तन्मात्रस्वरूप), and that the Mahábhúta A'kasa merges into the original Tanmátras, which then lapse into Bhútádi, the supersubtile rudiment matter, proto-matter (Chap. II, Pada 3 Sutra 14).

Parináma—Evolutionary Process :—When the Mahábhútas are once formed, the different kinds of substance are derived from them by the evolutionary process called Parináma (परिणाम, transformation). Matter is constantly undergoing change of state. The effect is only the cause in a new collocation (कारणस्थेव संस्थानमात्रं कार्यम्). Change is of two kinds :—

(1) Change by a spontaneous process, without external influence, including isomeric change (स्वाभाविक परिणाम). The Vedantists believe in

thick, *i.e.* less than one five-thousandth fraction of an inch in thickness ; and a fibril of the networks of Dhamaní or Nádí (nerve) that supply the pores of the skin (papillæ ? सुखानि रोमरूपप्रतिबद्धानि, Susruta) was supposed to be about a thousandth part of the finest hair in thickness, or $\frac{1}{1000}$ of the 'minimum visible', and therefore about $3 \cdot 10^{-32-14}$ of an inch thick (cf. सूक्ष्माङ्गीप्रचारतः रोमः सङ्ख्यमात्रेण तुल्यासु प्रचरति, Pañchadasí), but it is evident that these measures were arbitrarily fixed upon, instead of being arrived at by calculation or actual measurement. Indeed, Charaka expressly states that the number of Sírás and Dhamanís in the body (three million fifty-six thousand nine hundred) is only a conjectural estimate अनिर्दिष्टमनतः परं तद्वर्त्मन—S'árírasthána, Chap. VII).

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$AP = ap_4 \cdot (ak_1 \cdot v_1 \cdot t_1 \cdot e_1)$, ap_4 being the radicle.

$E = e_4 \cdot (ak_1 \cdot v_1 \cdot t_1 \cdot ap_1)$, e_4 being the radicle.

In forms of gross or compounded matter, the potential energies (or qualities) become actualised. The Mahābhūta Akāśa manifests sound; Vāyu, sound and mechanical energy; Tejas, sound, mechanical energy and heat-light; Ap, the energy of the taste-stimulus in addition; and finally Earth the energy of the smell-stimulus added to the foregoing.

The Pañchadasī characterises the different Mahābhūtas by their typical sounds; e.g., Akāśa by the echo (hollow booming sound); Vāyu (air) by a sibilant sound, hissing, susurration (imitative symbol, Visi); Tejas (fire) by a puffing (or roaring) sound (imitative symbol, Bhugubhugu); Ap (water) by a liquid sound (imitative symbol Culu Culu, gurgle, splash-splash, glut-glut); and finally Earth by a splitting or rattling sound, a crack or a thud (symbol, kad-kada)—Chap. II. Bhūtaviveka, S'loka 3, Pañchadasī, cf. also Jayanta, Mañjarī.)

Others hold that Akāśa, Ether, never enters as a component part, and is always one and indivisible. In this view, the four Mahābhūtas—Vāyu, Tejas, Ap and Earth alone are supposed to be com-

pounded, and by a process which may be called quaternion (cf. the Neo-Platonist quaternion) :—

$$V = v_3 (t_1 . ap_1 . e_1)$$

$$T = t_3 (v_1 . ap_1 . e_1)$$

$$AP = ap_3 (v_1 . t_1 . e_1)$$

$$E = e_3 (v_1 . t_1 . ap_1)$$

These compound forms, as before, are supposed to exercise their specific energies actively. Others again hold that the Mahábhútas—Tejas, Ap and Earth alone are compounded by a process named Trivrit-karana (triplication). Thus $T = t_2 (ap_1 . e_1)$, $AP = ap_2 (t_1 . e_1)$, $E = e_2 (t_1 . ap_1)$.

The Sūkshma-bhútas are forms of homogeneous and continuous matter, without any atomicity of structure ; the Mahábhútas are composite ; but even these are regarded as continuous, and ' without any atomic structure. The Vedánta speaks of Anu (Paramánu) not as an ultimate indivisible discrete constituent of matter, but as the smallest conceivable quantum or measure of matter. In the Sāṅkhya doctrine, the atomic structure is ordinarily accepted. The Gunas are supposed to be परिमित and अक्ष bounded and indefinitely small in size (except the Gunas giving rise to A'kāśa and Manas which are unlimited अपरिमित) ; and hence the Tanmátras and Paramánu must be conceived to have a discrete structure.

As I have already noted in my account of the genesis of Tanmátras and Paramánu, various

schools of Vedántists (*e.g.* the Rámánujists and the followers of Nimbárka) combined, in the orthodox fashion of the Smritis and the Puráṇas, the Vedántic theosophy with the Sāṅkhya cosmology especially as regards Prakṛiti and the order of creation and dissolution. For example, the Vedánta-kaustubhaprabhá, fortifying itself with texts from the Vishnu Purána and the Subala and Gopála Upanishadas, contends that at the cosmic dissolution (Pralaya), each Mahábhúta merges into the one that preceded it in the order of creation by first disintegrating into its own proper Tanmátric form (तन्मात्रस्वरूप), and that the Mahábhúta A'kasa merges into the original Tanmátras, which then lapse into Bhútádi, the supersubtile rudiment matter, proto-matter (Chap. II, Pada 3 Sutra 14).

Parináma—Evolutionary Process :—When the Mahábhútas are once formed, the different kinds of substance are derived from them by the evolutionary process called Parináma (परिणाम, transformation). Matter is constantly undergoing change of state. The effect is only the cause in a new collocation (कारणस्यैव संस्थानमात्रं कार्यम्). Change is of two kinds :—

(1) Change by a spontaneous process, without external influence, including isomeric change (स्वाभाविक परिणाम). The Vedantists believe in

spontaneous disintegration and reintegration. Action from without, impressed force *ab extra*, is not, *pace* the Naiyáyikas, always a condition of change of state (whether of rest or of motion);—nor is it necessary that more than one substance should combine to generate another substance or variety of substance (*e. g.* the formation of curds from milk, of ice from water *etc.*). All this is directed against the Nyáya doctrine (A'rambhaváda).

(2) Change due to combination with other substances (द्रव्यान्तरसंयोग). Such combination may produce (1) a compound substance possessing like qualities with the constituents (समानजातीयोत्पत्ति), or (2) unlike compounds with new qualities, "heteropathic effects" (विजातीयोत्पत्ति). Any new quality thus evolved through (chemical) combination is called *Samhata-bhúta-dharma* संघटतभूतधर्म), *e. g.* the intoxicating power of the fermented rice and molasses, which does not exist in the ingredients taken separately. (मद्यबीजानां प्रत्येकं चवर्त्तमानापि समुदायवशतः मदवृत्तिः दृश्यते). This *Sambhúyakriyā* (सम्भूयक्रिया, समुत्पन्न) corresponds to chemical combination, and the Vedantists, like the Sāṅkhyas, explain this only as the evolution of the latent energy (वृत्ति, चतुर्भूतवृत्ति) in a new collocation (संज्ञान, चवर्त्तव-संज्ञिवेश). But, unlike the mediæval Sāṅkhya, the Vedānta freely recognises the com-

bination of heterogeneous Bhútas. Thus, Earth, Ap, Tejas and Váyu freely combine in different proportions and groupings to produce the variety of substances in the world. For example, the animal organism is a compound of all the five Bhútas (पाच-भौतिक). It is not merely the concomitant or efficient causes that may be heterogeneous to the material cause, as the Naiyáyikas contend, but several heterogeneous substances or (Bhútas) may unite as 'material causes' to produce a new substance.

The Vedantists resolve all activity, physical, vital as well as psychical, into modes of motion, subtile cosmic motion (परिस्पन्द, सर्व्वलोकपरिस्पन्द—S'āṅkara ; वायोः परिस्पन्दात्मकत्वात्,—प्राणस्य परिस्पन्दात्मकत्वादेव—यद्वत् तं स्थूलं सूक्ष्मं च तत्सर्व्वं मनःस्पन्दितमात्मम्—S'āṅkara); but they give a separate substantive existence to the agents, the vital principle (प्राण) and the mind (मनः), though these are also evolutionary transformations of the Sūkshma Bhútas (forms of subtile matter). What is common to the Nyáya, the Vedānta and the Sāṅkhya is that Consciousness or Intelligence (चैतन्य) transcends Matter; but the Naiyáyikas as pluralists hold that vital and psychical activities are also immaterial and cannot be resolved into motion (परिस्पन्द);—the Vedāntists resolve these activities into subtile motion, but

ascribe them to a substantive quasi-material Life Principle and Mind, the all-mirroring Intelligence (चेतन्य) alone being immaterial and transcendent : and the Sāṅkhyas accept the substantive existence of the Mind principle (मनः) as derived co-ordinately with the Sūkshma Bhūtas or Tanmātras from individualised prakṛiti (Ahaṅkāra), but resolve Life into a mere resultant activity of the bodily organs, viz. the organs of sense and movement, and the psychic principle (मनः).

पञ्चीकरणः—विधा विधाय चैकैकं चतुर्धा प्रथमं पुनः ।

स्वस्वेतरद्वितीयश्रैशौजिनात् पञ्च पञ्च ते ।

यथा त्रिसर्गश्रुतौ सृष्टानां भूतानां स्फुटतरव्यवहारनामरूपस्य करणी-
पायतया द्विउत्करणं श्रुतं तद्वत् भूतपञ्चकसर्गश्रुतौ अपि तथा । तदानौ
पञ्चीकरणान्तरं आकाशशब्दीऽभिव्यज्यते स्फुटतयेति सर्व्वस्य योजनीयं
(विद्वन्मनोरंजिनी)—अस्ति हि शरीरे सर्व्वेषामपि भूतानां कार्य्य-
संप्रतिपत्तिः अवकाशव्यूहपवनहृद्गन्धाठिन्यानां सर्व्वजनानुभवसिद्धत्वात् ।
अतस्तत्कारणतया पञ्चानि भूतानि एकस्मिन् देहे सन्तीति स्थिते
तनुपटयोरिव अवयवावयवित्वमेव पञ्चभूतदेहयोर्युक्तं । न च स्वर्गश्रुत्यत्वात्
एकद्रव्यत्वात् च आकाशस्य आरम्भकत्वानुपपत्तिरिति वाच्यं । आरम्भ-
वादस्य अनङ्गीकारात् । एकस्यापि दुग्धावयविनी दध्यारम्भकत्वदर्शनात् ।
वस्तुतस्तु पञ्चानां भूतानां पञ्चात्मकत्वस्य दर्शितत्वात् आरम्भवादस्य
निराकृतत्वात् च । तस्मात् सिद्धं शरीरं पाञ्चभौतिकमिति । Vidvan-
manorāñjinī.

न तावत् समानजातीयमेव चारभते न भिन्नजातीयमिति नियमो नास्ति । समवाधिकारणे एव समानजातीयत्वाभ्युपगमः न कारणान्तर-विषय इति तदपि अनेकान्तिकम् । नापि अनेकमेव चारभते नैकमिति नियमोऽस्ति । अणुमनसीरायकक्षीरान्नाभ्युपगमात् । एकैकी हि परमाणु-वाद्यं स्वकक्षीरभते न द्रव्यान्तरैः संङ्ख्य इत्यभ्युपगम्यते । द्रव्यान्तरे एव अनेकारम्भकत्वनियम इति चेत् न परिणामाभ्युपगमात् । तदेव तु द्रव्यं विशेषवदवस्थान्तरं आपद्यमानं कार्यं नामाभ्युपगम्यते । तच्च क्वचित् अनेकं परिणमते मृद्धीजाङ्गुरादिभावेन, क्वचिदेकं परिणमते क्षीरादि-द्रव्यादिभावेन । नेश्वरशासनं अस्ति अनेकं एव कारणं कार्यं जनयति इति ! S'āṅkara, S'āriraka bhāshya, Sūtra 7. Pada 3, Adhyāya II).

The atomic theory of the Buddhists :—The Vaibhāshikas and the Sautrāntikas hold that the Vāyu-atoms are touch-sensibles, having impact or pressure for their characteristic property, and by aggregation from the element Vāyu; the Tejas-atoms are colour-and-touch-sensibles, having heat for their characteristic, and by aggregation from the Tejas Bhūta; the Ap-atoms are taste-colour-and-touch-sensibles with a characteristic viscosity, and form the Ap-element by aggregation; and finally the Earth-atoms are smell-taste-colour-and-touch-sensibles possessing a characteristic dryness or roughness (खरत्न), and by their aggregation form the Earth-element. The Bhūtas

thus originated combine to form aggregates, which are classed as inorganic substances, organisms and organs. (कामेष्टद्रव्यकोऽयुः—Udyotakara's extract from the Buddhist Sūtras, Nyāya Vārtika. Chap. I. A'hnika 1, Sūtra, 14. cf. Vāchaspati's fuller extract :—कामेष्टद्रव्यकोऽयुः इदमातुरदमातुः काममातुः—also the Buddhist commentary :—कामे काममातौ कामेष्टद्रव्यकोऽयुः । इदमसगम्यव्यवर्त इति चत्वारि द्रव्याणि प्रविध्यप्तेजीवातुः इति चत्वारि—Vāchaspati. Tātparyyaśikā, loc. cit.—also खरवेष्टोष्टेरणसमावाणि मूतानि—*vide* Udyotakara, Chap. III, A'hnikā 2, Sūtra 12,—*Vide* also Śrīnivāsa's Vedānta-kaustubha, Chap. II, Pada 2. Sūtra 18).

The atomic theory of the Jainas :—Of the nine categories of the Jainas, that of Ajīva (the not-soul or non-Ego) consists of five entities, four of which are immaterial (अमूर्त), viz., merit, demerit, space and Time, and the fifth, material (मूर्त, possessing figure). The last is called Pudgala (matter), and this alone is the vehicle of Energy, which is essentially kinetic, *i.e.* of the nature of motion. Everything in the world of not-soul (the non-Ego) is either an entity (द्रव्य), or a change of state in an entity (पर्याय). Pudgala (matter) and its changes of state (पर्याय), whether of the nature of subtile motion (परिणाम) or of Evolution (परिवर्तन), must furnish the *physical* as opposed to the *metaphysical* basis of all our explanations of Nature. Pud-

gala (Matter) exists in two forms,—*Anu* (atom) and *Skandha* (aggregate). The Jains begin with an absolutely homogeneous mass of *Pudgalas*, which, by differentiation (भेद) breaks up into several kinds of atoms qualitatively determined, and by differentiation, integration, and differentiation in the integrated (संचातात्, भेदात्, संचातभेदात्—*Umā-śvātī*, Chap. V, *Sūtra* 26), forms aggregates (*Skandhas*). An *Anu* has no parts, no beginning, middle or end. An *Anu* is not only infinitesimal, but also eternal and ultimate. A *Skandha* may vary from a binary aggregate (द्वयवृत्त) to an infinitum (अनन्तावृत्त). A binary *Skandha* is an aggregate of two *Anus* (atoms), a tertiary *Skandha* is formed by the addition of an atom (*Anu*) to the binary (द्वयवृत्त) and so on *ad infinitum*. The ascending grades are (1) what can be numbered (संख्येय), (2) indefinitely large (असंख्येय), (3) infinity of the first order (अनन्त), (4) infinity of the second order (अनन्तानन्त), and so on.

General Properties of Matter :—

The specific characters of the *Pudgalas* (Matter) are of two kinds, (1) those which are found in atoms as well as in aggregates, and (2) those which are found only in aggregates. Qualities of touch, taste, smell and colour come under the first head.

The original Pudgalas being homogeneous and indeterminate, all sensible qualities, including the infra-sensible qualities of atoms, are the result of evolution (परिणाम). Every atom thus evolved possesses an infra-sensible (or potential) taste, smell and colour, (one kind of each) and two infra-sensible tactile qualities, *e.g.* a certain degree of roughness or smoothness (or dryness and moistness?) and of heat or cold. Earth-atoms, Ap-atoms, *etc.* are but differentiations of the originally homogeneous Pudgalas. The tactile qualities (स्पर्श, तन्मय, उष्ण, शीत) appear first, but qualities of taste, smell and colour are involved in the possession of tactile qualities. An aggregate (Skandha), whether binary, tertiary or of a higher order, possesses (in addition to touch, taste, smell, and colour) the following physical characters:—(1) sound, (2) atomic linking, or mutual attraction and repulsion of atoms, (3) dimension, small or great, (4) figure, (5) divisibility, (6) opacity and casting of shadows, and (7) radiant heat and light.

Sensible qualities. Tactile qualities are of the following kinds—hardness or softness, heaviness or lightness (degrees of pressure), heat or cold, and roughness or smoothness (or dryness and viscosity?). Of these, the atoms (Anus) possess only temperature, and degrees of roughness or smoothness, but

all the four kinds of tactile qualities in different degrees and combinations characterise aggregates of matter from the binary molecule upwards. The Jainas appear to have thought that gravity was developed in molecules as the result of atomic linking. Simple tastes are of five kinds,—bitter, pungent, astringent, acid and sweet. Salt is supposed by some to be resolvable into sweet, while others consider it as a compound taste. Smells are either pleasant or unpleasant. Mallishena notes some elementary varieties of unpleasant smell, *e.g.* the smell of asafœtida, ordure, *etc.* The simple colours are five—black, blue, red, yellow and white. Sounds may be classed as loud or faint, bass (thick) or treble (hollow), clang or articulate speech.

The most remarkable contribution of the Jainas to the atomic theory relates to their analysis of atomic linking, or the mutual attraction (or repulsion) of atoms, in the formation of molecules. The question is raised in Umāsvāti's Jaina Sūtras (circa A. D. 40)—what constitutes atomic linking? Is mere contact (or juxtaposition) of atoms sufficient to cause linking? No distinction is here made between the forces that bind together atoms of the same Bhūta, and the chemical affinity of one Bhūta to another. The Jainas hold that the different classes of elementary substances (Bhūtas) are all evolved from the same primordial atoms.

The intra-atomic forces which lead to the formation of chemical compounds do not therefore differ in kind from those that explain the original linking of atoms to form molecules.

Mere juxtaposition (संयोग) is insufficient; *linking* of atoms or molecules must follow before a compound can be produced. The linking takes place under different conditions. Ordinarily speaking, one particle of matter (द्रव्य) must be negative, and other positive (विपरीतगुणयुक्त); the two particles must have two peculiar opposite qualities, roughness and smoothness (रुचल and स्निग्धल or dryness and viscosity?), to make the linking possible. But no linking takes place, where the qualities, though opposed, are very defective or feeble (अल्पगुणयुक्त). We have seen that, ordinarily speaking, two homogeneous particles, i.e. both positive, or both negative, do not unite. This is the case where the opposed qualities are equal in intensity. But if the strength or intensity of the one is twice as great as that of the other, or exceeds that proportion, then even similar particles may be attracted towards each other. In every case, change of state in both the particles is supposed to be the result of this linking, and the physical characters of the aggregate depend on the nature of this linking. When particles of equal intensity (negative and positive) modify each

other, there is mutual action ; in cases of unequal intensity, the higher intensity transforms the lower, it being apparently thought that an influence proceeds from the higher to the lower. All changes in the qualities of atoms depend on this linking. A crude anticipation this, of the ionic theory of chemical combinations, very crude but immensely suggestive, and possibly based on the observed electrification of smooth and rough surfaces as the result of rubbing. The interpretation of रूच and स्निग्ध as dry and viscous (or as vitreous and resinous ?) must be rejected in this connection as untenable. The Tattvārthādhigama of Umāsvatī, which expounds the theory, most probably dates back to the first half of the first century A. D. Cf. Umāsvatī—Tattvādhigama, Chap. V.

(अजीवकाया चर्मोचर्मोकाग्रपुङ्गवाः । द्रव्याणि जीवाश्च । नित्या-
वस्थितानि चरुपाणि । रुपिणः पुङ्गवाः । आकाशादेकद्रव्याणि ।
निष्क्रियाणि च । पुद्गलजीवास्तु क्रियावन्तः । (क्रियेतं गतिकर्मोह) ।
सर्वेषां प्रदिशाः सन्ति अन्यत्र परमासीः । संख्येयासंख्येयाश्च पुद्गलानां ।
मासीः । अर्धरसगन्धवर्णवन्तः पुद्गलाः । तत्र अर्शोऽष्टविधः कठिनी
सदुर्गुणैर्लघुः शीत उष्णः स्निग्धः रूच इति । रसः पञ्चविधकित्तः
कटुः कषायोऽस्त्री मधुर इति । गन्धी द्विविधः सुरभिरसुराभय । वर्णः
पञ्चविधः कृष्णो नीलो खोदितः पीतः प्लव इति ।

अद्वयत्वसीमास्त्रीक्यासंख्यानभेदतमन्हायातपीपीतवक्तव्य । तत्र अद्वः
वक्त्रिणः तसी वितती वनः शशिरी वर्षी भाव इति । अक्षयः

स्तम्भाश्च । उक्तं च । कारणमेव तदन्यं सूक्ष्मी नित्यञ्च भवति परमाणुः ।
 एकरसगन्धवर्णो हिरण्यः कार्यलिङ्गश्च । तदाश्वोऽवृद्धाः स्तम्भास्तु बद्धा
 एव । स्तम्भास्वावत् संघातभेदेभ्य उत्पद्यन्ते । संघातभेदादिति । इयोः
 परमाण्वोः संघाताद्विप्रदेशः । विप्रदेशस्यापीश्व संघातात् विप्रदेशः ।
 एवं संख्येयानामसंख्येयानामनन्तानां अनन्तानन्तानां च प्रदेशानां
 संघातात् प्रदेशाः । भेदादणुः । भेदादेव परमाणुः उत्पद्यते न
 संघातादिति । अत्राह । किं संयोगमात्रादेव संघातो भवति ।
 आहोस्त्रिदक्षि कश्चिद्विशेष इति । अभीक्ष्यते । सति संयोगे बद्धस्य
 संघातो भवतीति । स्त्रिगुणत्वाद्बन्धः । न जघन्यगुणानाम् । त्रिगुण-
 बन्धयोः पुद्गलयोः सृष्टयोर्बन्धो भवतीति । जघन्यगुणस्त्रिगुणानां
 जघन्यगुणरूपाणां च परस्परेश्व बन्धो न भवतीति । उक्तं भवता
 जघन्यगुणवर्जानां त्रिगुणानां बन्धेष्व बन्धानां च त्रिगुणेन सह बन्धो
 भवतीति । अथ तुल्यगुणयोः किमत्यन्तप्रतिषेध इति । अभीक्ष्यते ।
 न । गुणसाम्ये सदृशानां । गुणसाम्ये सति सदृशानां बन्धो न भवति ।
 तद्वदथा । तुल्यगुणस्त्रिगुणस्य तुल्यगुणस्त्रिगुणेन तुल्यगुणरूपस्य तुल्यगुण-
 रूपस्य इति । अत्राह सदृशयदृश्यं किमपेक्षते इति । अभीक्ष्यते ।
 गुणवैषम्ये सदृशानां बन्धो भवति इति । अत्राह किमविशिष्टेष्व गुण-
 वैषम्ये सदृशानां बन्धो भवतीति । अभीक्ष्यते । वायुकादिगुणानां
 तु वायुकादिगुणानां सदृशानां बन्धो भवति । त्रिगुणाद्यधिकस्त्रिगुणेन ।
 त्रिगुणाद्यधिकस्त्रिगुणस्य त्रिगुणेन । रूपकापि त्रिगुणाद्यधिकरूपस्य
 रूपस्य । एकादिगुणाधिकरीत्यु सदृशरीर्बन्धो न भवति । अत्राह
 परमाणुषु स्तम्भेषु च वै अर्थादयो गुणान्ते किं व्यवस्थिताः तेषु

आहोस्त्रिदश्वयस्त्रिता इति । चनोच्यते । अव्यवस्थितायुतः । परिचामान् ।
 अनाहं इयोरपि बध्यमानयोर्गुणवत्त्वे सति कथं परिचामो भवति इति ।
 उच्यते । बन्धे समाधिकौ पारिचामिकौ । बन्धे सति समगुणस्य
 समगुणः परिचामको भवति । अधिकगुणो हीनस्येति । Umāsvātf,
 Tattvārthādhigama, Chap. V).

The Nyāya-Vaisheshika chemical theory : a
 brief summary.

I must content myself here with a brief and
 rapid sketch of the chemistry of the Nyāya-Vaisheshika, which I shall elaborate in connection with
 the mechanics and physics of the ancient Hindus
 in a separate paper.

The relation of the specific characters of molecules (and higher aggregates) to the original
 atomic qualities is reduced in the Nyāya-Vaisheshika
 to the following canons :— (a) कार्यगुणं कारवगुण-
 पूर्वकम् । (b) समानजातीयसंयोगः द्रव्यारम्भकः न विजातीयसंयोगः
 (Here, द्रव्य is used in a narrow technical sense,
 so as to exclude the quasi-compound sub-stances).
 (c) अपाककूपरसगन्धस्पर्शपरिमाणेकत्वैकपृथक्गुणवत्त्वद्रवत्वकोष्ठवेगाः
 कारवगुणपूर्वकाः । (d) रूपरसगन्धस्पर्शस्पर्शवत्त्वपरिमाणेकत्वैकपृथक्गुणवत्त्वः
 समानजात्यारम्भकाः । No separate explanation is necessary,
 as the canons are embodied in the following
 exposition.

Theory of Atomic combination :—

The four kinds of Atoms are Earth, Ap, Tejas and Vāyu atoms, possessed of characteristic mass, numerical unit, weight, fluidity (or its opposite), viscosity (or its opposite), velocity (or quantity of impressed motion—Vega); also characteristic potential colour, taste, smell or touch, not produced by the chemical operation of heat अपाकज-रूपरसगन्धस्पर्शपरिमाणोक्तत्वे क-पृथक्-गुणत्वद्रव्योद्भवेनाः). A'kāśa has no atomic structure (निरवयव), and is absolutely inert (निष्क्रिय), being posited only as the substratum of sound, which is supposed to travel wave-like in the manifesting medium or vehicle of Vāyu (air). Only the other four Bhūtas unite (or disunite) in atomic or molecular forms. The orthodox view is that, the presence of Earth-atoms is necessary whenever chemical transformation under the operation of heat (पाचनोत्पत्ति) takes place.

Atoms cannot exist in an uncombined state in Creation (Sivādityā, Sapta-padārthi—*Vide* commentary, where, however, it is noted that still atmospheric air is believed to be monatomic in structure, i. e. to consist of masses of atoms in a loose uncombined state—(क्षीणतन्मायुक्षु परमायुसमूह एव अनारब्ध-द्रव्यः ।

The atoms may combine in one or other of the following ways :—

1. One Earth-atom, by an original tendency, unites with another, to form a binary molecule (द्वयकण). In the same way, binary molecules of the other Bhūtas are formed. The atoms are possessed of an inherent Parispanda (rotary or vibratory motion), and when they unite in pairs, *so long as there is no chemical operation under the action of heat corpuscles*, the original qualities of the atoms produce homogeneous qualities in the binary molecules.

The question as to the existence of a triad, a tetrad, a pentad *etc.* of atoms is one of the moot points of the Nyāya-Vaiśeṣika. The orthodox view is that, the primordial infinitesimal particles (atoms) start with an incessant vibratory motion अनवरतपरिस्पन्दमानापरिमितपञ्चमादिपरमाणवः, Raghunātha S'īromani—गतिशीलत्वात् पतनव्यपदेशाः पतन्तीति, Udayana, Kṣumāñjali), and an inherent impulse that drives them to unite in pairs—a sort of 'monovalency', *as it were*, exhausted with the formation of a binary molecule. The binary molecules now combine by threes, fours, fives, *etc.* to form larger aggregates as well as the variety of elementary substances, the particular collocation in any case being not only determined by physical causes, but also serving to satisfy the ends of the moral Law in creation (ब्रह्म, कार्यं), (द्वयकणैर्वहुभिरारभ्यते इत्यपि निबन्धी,

न बाध्या । बहुषु लनियमः । कदाचित् विभिरारभते इति । वायुकमिलयुचते, कदाचिच्चतुर्भिरारभते कदाचित् पञ्चभिरिति यदेष्टं कल्पना । चट्टचक्रात् तथा तथा तेषां श्रुद्धौ यथा यथा तदारब्धेषु चपरजातयो व्यव्यन्ते । चट्टकारिता सर्वभाषाणां छटिः । S'ridhara, Nyāya-Kandalī, वृद्धिबोधिनिरूपणम् ।) Cf. Vāchaspati's report, Bhāmatī, Chap. II., Pada II. Sūtra II. यदा चतुरशुकमारभते चतुर्णां वायुकानामारम्भकत्वात् । Prasastapāda appears to have originated this view (परमाच्चतुर्शुकेषु बहुत्वसंख्या तैरारब्धे वायुकादिलक्षणे—Prasastapāda, परिमाण निरूपणम्); but that another view was also maintained in the Vaisheshika School is evident from the brief summary of Kanāda's system given in Utpala's commentary on the Vṛhatsamhitā, and this indeed also follows from S'ridhara's admissions in the Kandalī. On this view, also, atoms have an inherent tendency to unite, but some unite in pairs, others in triads, others in tetrads, etc. This may happen in two ways,—either by the atoms falling into groups of threes, fours, etc. direct, or by the successive addition of one atom to each preceding aggregate.

A triad (Tryanuka), then, holds together three atoms (Anus), not three binary molecules (Dvyanukas) as on the orthodox hypothesis. Similarly with tetrads, pentads etc. चतुर्विधाः परमाणवः क्षितिजकादिवायूनाम् ।

हार्था परमाणुभ्यां द्वाणुकमारभ्यते त्रिभिः परमाणुभिस्त्राणुकमारभ्यते इति क्रमेण स्थूलकार्य-द्रव्यस्योत्पत्तिः । Utpala, Chap. 1. S'loka 7 ; cf, also S'rīdhara's admission, अथवा यदि परमाणवो द्वाणुकमारभ्य तत्सङ्घितास्त्राणुकमारभन्ते त्राणुकसङ्घितास्तु द्रव्यान्तरम् तथापि कुतो विन्यस्य अथङ्गम्). S'āṅkara seems to speak of two binary molecules in the Vaiseshika as forming a tetrad, (यदापि द्वे द्वाणुके चतुरणुकमारभ्यते—S'ārīraka-Bhāṣhya, Chap. II, Pada Sūtra, II, where the Bhāmntī gives a forced interpretation).

In Prasastapāda's view, these binary molecules are grouped by threes, fours, fives *etc.* (त्राणुक, चतुरणुक) to form different isomeric modifications. The variety of Earth-substances is due to differences in the arrangements of the molecules (*e.g.* their greater or less density, and, above all, their grouping or collocation व्यूह, अवयवसन्निवेश), which account for the specific characters (अपरजाति) manifested by these isomeric substances. सा पृथिवी च स्वेय्याद्यवयवसन्निवेशविशिष्टा अपरजातिबहुलीयेता । Prasastapāda, पृथिवीनिरूपणम् । स्वेय्यं निविडत्वम् । आदिशब्दात् प्रशिक्षितत्वादिरियङ् । परमाण्वादियु अपरजात्यभावेऽपि अदृष्टवशात् तथा तथा तेषां व्यूहः यथा यथा तदारब्धेषु अपरजातयो व्यन्वन्ते । S'rīdhara, Kandalī, *ibid.*

स्वेय्यं स्थिरता चिरकालावस्थायित्वमिति यावत् । आदिशब्दवाचित्वकत्वं जलादिव्यूहविरोधित्वञ्च । अवयवसन्निवेशः तत्तत्सामान्याविशेषाभिन्नञ्च-

संज्ञानविधिषाः । न हि एतद्द्रव्यान्तरं सत्त्वमि । जलादीनां यत्किञ्चित्-
 कार्यवद्वेगवद्द्रव्योपनिपातमात्रेणैव सङ्गुत्वात् । Udayana, Kiranā-
 vali, *ibid.* These original differences in molecular
 grouping leading to distinctions of genera and species,
 however mechanically or physically explained, come
 also under the operation of moral and metaphysical
 causes (चरुट, कार्य), i.e., of ideal ends in the moral
 government of the universe, which are superimposed
 upon the physical order, but which do not come
 within the scope of Natural philosophy. An elemen-
 tary substance thus produced by primary atomic com-
 bination, may, however, suffer qualitative change
 under the influence of heat (पाक्वजोत्पत्ति). The pro-
 cess is as follows :—(1) the impact of heat corpuscles
 decomposes the binary (tertiary, or quaternary) mole-
 cules into homogeneous atoms possessing only the
 generic characters of the Bhūta concerned ;—(2) the
 impacts of heat particles continue, and transform the
 characters of the atoms; determining them all in
 the same way ;—(3) the heat particles continue to
 impinge, and reunite the atoms so transformed to
 form binary (or other) molecules, in different orders
 or arrangements, which account for the specific
 characters or qualities finally produced. The Vaise-
 shika holds that there is decomposition into

homogeneous atoms, transformation of atomic qualities, and finally recombination, all under the influence of heat. The Nyáya on the other hand thinks that the molecules and larger aggregates assume the new characters under the influence of heat without decomposition into homogeneous atoms, or change of atomic characters (पितृपाक or पिठरपाक).

तेषामनुभावेन विनाशः परिकल्प्यते। सर्व्वावयवेषु चान्वर्द्धित-
वातपूर्वकपूर्वकपादिविलक्षणगुणोपलब्धेरन्तःप्रवेशः ज्ञानादीरनुमीयते तेन
वेगवता वहिर्द्रव्येषु गोदनात् अभिघातात् वा नूनं घटाद्यारम्भकेषु
अवयवेषु क्षिप्त्वा जायते क्षियाती विभागः विभागात् द्रव्यारम्भकसंयोग-
विनाशः। तद्विनाशात् द्रव्यविनाशः। पक्षाच्च ज्ञानादिगुणानवगन्तः
रक्षादिगुणान्तरयोगमनुभवन्तः—चट्टप्रथमाद्याः परस्परं संयुज्य वायुकादि-
प्रक्रमेण तादृशमेव घटादिकादभारमन्ते। एवं तदनातपहस्यमानेषु
वायादिकेषु एव एव जायः शरीरे अपि सदर्थेन तेनसा पञ्चमानेषु
अन्नपानादिषु रसमन्त्राणामुभावेन परिचामनुपगच्छत्सु प्रायेण प्रतिपक्ष-
मुत्पादविनाशी संभवत इति। (Jayanta, Nyāyamāñjarī
सूत्रचैतन्य-पूर्वपक्ष). This is the Vaisesika view, but
Jayanta himself inclines to the opposite view :—
प्रकृतव्यविरतयेव कार्यद्रव्यक घटादिः चारणात् चान्वर्द्धितः कषाणुप्रवेशक-
पाक्षीपक्षेः चर्च विनाशकत्ववत्। पिठरपाकपक्ष एव वैवचः। *ibid.*
The Nyāya view :—श्री जीनावयवासे पूर्ववत्परिभावेन

व्यूहान्तरमापद्यते व्यूहान्तरापत्तौ च पृथिवीधातुरब्धातुना संयुज्यते
 आन्तरिण तेजसा पञ्चमानो रसद्रव्यं निर्वर्तयति सरसः प्रव्यावयवसङ्घतो-
 ऽङ्गुरादिभावमापद्यते । परमास्त्रस्यानि बीजानि भवन्तीत्येतन्न प्रतिपद्यामहे ।
 यस्याऽऽहस्यादिबीजमुष्णान्द्रावस्थामादिं कृत्वा यावदुपान्तं शालिबीजकायं
 तावन्न कदाचित् परमाण्ववस्थं भवति । यदि तु स्यात् कदाचित् नोपलभ्येत ।
 Udyotakara, Chap. III, A'hnika I, Sūtra 4.

11. Chemical combination (सम्भूयक्रिया, संघतक्रिया).
 Chemical combination takes place either between two or more substances which are isomeric modi-
 fications of the same Bhūta, or between substances which are modes of different Bhūtas.

A. Mono-Bhautic compounds. The simplest compounds are Mono-Bhautic compounds, i. e. compounds of different substances which are isomeric modes of the same Bhūta.

(a) Mono-Bhautic compounds of the first order :—Under the impact or impulse (अभिघात or नीदन) of heat corpuscles, the substances in chemical contact (चारणक संघीन) break up into their atoms. These atoms are homogeneous, possessing only the original physical and chemical characters of the Bhūta concerned. As the speci-

fic differences between isomeric substances arise from the arrangement or collocation of the atoms, the substances lose their distinctive marks on decomposition into the latter.

(न च परमाणुषु अपरजातिसेदो विद्यते न च
यवबीजग्राणिबीजपरमाणूनां कश्चिद्विशेषः ।

Uddiyotakara, Chap. III, A'hnika I,

Sútra 4. न च यत्नशीलतपरमाणूनां कश्चिद्विशेषः

पार्थिवत्वाविशेषात् । S'ridhara, Nyāya-

Kandalí, पृथिवानिरूपणम्) । Under the

continued impact, (or, it may be, impulse) of heat particles (वेगवता वर्द्ध-

द्रव्येषु जीदनात् अभिघातात् वा—Jayanta),

these atoms take on new characters. It is heat and heat alone that

can cause this transformation of the colours, tastes, smells, etc., in these

original Bhúta-atoms. What parti-

cular colours, tastes, smells or physical characters will be produced in the

atoms depends (1) on the nature of the constituent substances in con-

tact, (2) the intensity or degree of

the heat (खर, चद्रु or मध्यम पाक), and

(3) the species of Tejas-corpuscles

the impinge on the atoms, or the nature of the impact (विक्षयकालः-संयोगः). (न ब्रूमीऽग्नि-संयोगात् एकाद्यात् उपादान इति अपि तु पूर्वकपादिविशेषादेवात् । यद्वद्व्यं पञ्चमे अग्निसंयोगेन तस्य ये पूर्वकपादव्यवस्थाः सः स्रजती विशिष्टसमवेचनायः अग्निसंयोगः उत्तरान् कपादीन् विप्रिष्टानारभते । *Vide also Uddyotakara III, 2, Sūtra 14. Cf. also Vāchaspati, I, 1, Sūtra 4.* अजातमभेदे अपि उपादानस्य पिठरस्य औष्णापराष्णस्य च यद्विसंयोगस्य पूर्वकपादिप्रभंशानां कारणानां भेदात् भिन्नजातीया जायन्त गन्धकपरस्यर्था इति सिद्धान्तः) ।

Now when the atoms have all been determined in the same way, they begin to recombine again under the impact (or impulse) of the heat-particles in binary molecules, (or tertiary, etc.), and these in higher aggregates. It seems to be generally held that, at the final step one or more atoms of one constituent substance unite with one or more atoms of the other constituent substance or substances to form a molecule of the com-

pound; but the question is not of much significance for Mono-Bhautic compounds of the first order, as, in these cases; the atoms have before this all lost their distinctive characters and become homogeneously transformed. The compound so produced will possess the new characters of the transformed atoms, so far as taste, colour, smell, *etc.* are concerned, but as the molecular arrangement or structure (*अणु, अणुसंघटन*) may vary, different compound substances may result from the same components.

- (b) Mono-Bhautic compounds of higher orders :—Again, Mono-Bhautic compounds of the first order may chemically combine to form higher compounds, and as the ultimate Bhúta substratum is the same, the process of decomposition and recombination will be essentially the same as before. The only doubtful point is whether in this case the component compound substances are broken up only into their constituent molecules, or into the original homogeneous Bhúta atoms. Some of the later Vaisheshika Scho-

liasts hold that the latter happens in every case of chemical composition, however complex, but the earlier Vaiseshika conceived that in the case of compounds of compounds, the decomposition does not proceed so far as the original Bhúta atoms ; but that it is the specifically determined atoms constituting the molecules of the component compounds that are transformed under the impact of the heat-corpuscles ; and then one such transformed atom (one or more according to another version) from the molecule of one component unites with one similarly transformed atom (one or more according to the other version) from the molecule of the other component. Prasastapáda, the great Vaiseshika Doctor, holds this view. When, for example, in the fertilised ovum, the germ and the sperm substances, which, in the Vaiseshika view, are both isomeric modes of Earth (with accompaniments of other Bhútas), unite, both are broken up into homogeneous Earth-atoms, and it is these that chemically combine under the animal heat (and bio motor

Energy, वायु) to form the germ-plasm (कलस). But, next, when the germ-plasm develops, deriving its nutrition from the chyle (blood) of the mother, the animal heat breaks up the molecules of the germ-plasm into its constituent atoms (कलसारम्भक-परमाणवः), i.e., into atoms specifically determined, which by their grouping formed the germ-plasm, and then these germ-plasm atoms as radicals chemically combine with the atoms of the food constituents, and thus produce cells and tissues. (समुत्पन्नवाक्यैः कलसारम्भकपरमाणुभिः चट्टवशात् उपजातक्रियैः आहारपरमाणुभिः सह सम्भूय शरीरान्तरमारभ्यते इत्येषा कल्पना । पितुः शुक्रं मातुः शीघ्रितं तयोः सन्निपातानन्तरं जठरानलसम्बन्धात् शुक्रशीघ्रितारम्भकेषु परमाणुषु पूर्वैकपादिविनाशे सति समानगुणान्तरौत्पत्तौ वायुकादि-प्रक्रमेण कलसशरीरौत्पत्तिः ।
...तत्र मातुराहाररसः मादया संक्रामति चट्टवशात् तत्र पुनर्जठरानलसम्बन्धात् कलसारम्भकपरमाणुषु क्रियाविभागादिन्यायैर्न कलसशरीरौ नष्टं समुत्पन्नवाक्यैः कलसारम्भकपरमाणुभिः चट्टवशात् उपजातक्रियैः

आहारपरमाणुभिः सह संयुज्य ग्रहीरान्तरमारभ्यते
 इत्येवा कल्पना । Śrīdhara, Kandalī,
 पृथिवीनिर्गमपञ्चम् ।) In this hypothesis
 (कल्पना), it is assumed that the
 atoms are similarly transformed, *i.e.*,
 become endowed with the colour,
 taste, smell, *etc.* of the product (the
 cell or tissue), the moment before
 the chemical combination takes place.
 Similarly, when milk is transformed
 into curd, one view is that the trans-
 formation takes place (under internal
 heat) in the constituent atoms of
 the milk molecules, atoms specifically
 determined as milk, and not in the
 original atoms of the Bhūta (or Bhūtas)
 entering into composition of milk.
 (Cf. एवं महादुग्धारणकैः परमाणुभिरेव दध्मा-
 रभ्यते । एकमहिमैव दध्मारणकैरेव पर-
 माणुभिर्नवनीतारण्यः इति दिक् । Nyāya-
 bodhinī, on Annam Bhatta's Tarka-
 saṅgraha.) Cf. Dinakarī, on the other
 hand—आणुविकल्पदुग्धसंयुज्यतेऽपि तत्र (दध्मः) ।)
 In these cases, the atomic contact
 is called constituent contact

(चारभक्तसंयोग), and all the atoms are equally regarded as material causes (उत्पादानकारण or समवायिकारण) of the compound.

- B. Hetero-Bhautic 'quasi-compounds'.—The Nyāya-Vaiśeṣika maintains that in the case of bi-Bhautic (or poly-Bhautic) compounds, which are only quasi-compounds, there is another kind of contact between the heterogeneous atoms of the different Bhūtas, which may be called dynamic contact and is distinguished in its operations as Upashtambha, Vishtambha or Avashāmbha (उपष्टम्भ, विष्टम्भ or अवष्टम्भ). In some cases, it so happens that the atoms of different isomeric modes of the same Bhūta do not chemically combine under the mere application of heat ;—they require to be surrounded (and 'excited', 'energised') by atoms of different Bhūtas. For example, in the case of the oils and fats as well as of plant saps and fruit juices the Earth-atoms must be dissolved in water (Ap), and it is only when the water atoms (Ap-atoms) congregate round the former that dynamic intra-atomic

forces are set up, and the Earth-atoms (with the water atoms in dynamic contact) now take on peculiar infra-sensible characters (colours, tastes, smells) under the impact of the heat corpuscles, and then, under further impact, fall into groupings or collocations (of a very peculiar nature, to be presently explained) which determine the nature of the composite substance thus produced. Here it is the water-atoms that are dynamic (उपटम्बक), and excite the Earth-atoms, and these substances, oils and fats (तेजवर्ग and द्रववर्ग), as well as acids (अम्लवर्ग) are, because of the Earth radicles regarded as Earth-compounds (or Earth-substances). (पाक्व-तत्वाविधनम्बरसङ्ख्यादिभिः परमात्मिहंशुकादिक्रमिण्य द्रुतादिद्रव्यमारभ्यते । तत्र च उपटम्बकतया निमित्ततामापन्नाः पानीयावयवाः । तेषां संयुक्तसमवायिन्य खेदकमीपकभ्यते । तेजसीरादिषु पार्थिवत्वसिद्धिः । तेजस्य भीमानखीयनमात् द्रववत् । Udayana). In the above instances, Ap (water) acts as dynamic (Upash-tambhaka, (उपटम्बक), but Tejas

and Váyu can also act in the same way on Earth-particles. Conversely, Earth-particles may act dynamically on the atoms of the other Bhútas. For example, in the case of mercury and the metals which are conceived in the Nyáya-Vaisesika to be igneous bodies (in fact they are supposed to be formed under the subterranean heat चाकरज), the Tejas corpuscles are believed to form the radicles, and the Earth-particles are dynamic (उपटन्त्रक).

(सुवर्णादि निरन्तरं आयमानमपि न पूर्वरूपं जहाति । तेनैव द्रव्याकारिण प्रतिबलत्वात् उपटन्त्रकीडपि पार्श्व-भागः सङ्घट्टक एवानुवर्तते, यत्तु पुटपाकादिना रक्तसारता दृश्यते तन्निशीमूताभिभावकतत्तद्व्योप-गमात् । एतेन पारदादि व्याख्यातम् । Udayana, Kiranāvalī, तेजोनिरूपणम् । Cf. also बीडपि तेजसमिच्छति सुवर्णे तेनाप्यत्र पार्श्वी भाग उपटन्त्रक एटव्यः ।)

It may be here noted that Gaṅgesa, the author of the Tattvachintāmaṇi, conjectures that even gold can be evaporated or made to disappear by the application of intense heat ;

अथ द्रुवद्रुववर्धः क्षमः प्रदीपः प्रवक्ष्यमान-
 संदीपनं द्रुववर्धनात् तद्वद्वता नक्षति । But
 Mathuránátha notes here—अथवाप्यायो-
 च्छेदयति । (द्रुववर्धनाद्वद्वता) .

But while every Bhúta can act dyna-
 mically as उपपन्नक 'energiser',
 'exciter', it is the Earth-Bhúta alone
 which is capable of exercising the
 power of arrest or inhibition of
 molecular motion or the motion of
 particles due to gravity as in fluids
 (Vishtambha, विष्टम्भ), or the power
 of counteracting the tendency in a
 given set of atoms to fall into a pe-
 culiar order or group (अङ्गविरीचिम्बम्),
 (न च पार्थिवम् पृथ्वी द्रव्यान्तरं नष्टविष्टम्बानि
 पूर्वमङ्गं वा निवृत्ति । Udayana, Kira-
 návali, इतिविनीतवत् । विष्टम्भकं क्षमा-
 विष्टम्बानामवद्रव्यान्तरविष्टम्बकम् । अङ्गविरीचिम्बं
 च क्षमाविष्टम्बकवत्पतनः प्रवृत्तिवत्कम् । Vardha-
 mána, Kiranávalíprakāsa, *ibid.*)

Oils, fats, milks—Bi-bhaotic quasi-compounds,
 with Ap as energiser :—Oleaginous substances

(पाच्यवैचारः उच्यते) are divided by Udayana into (1) oils, derived from vegetables, (2) butters derived from milk, and (3) fats derived from animals. The medical schools, as we have seen, recognise animal oils as distinguished from vegetable oils. Vegetable fats (*e. g.* विषण्ण) are also mentioned. Vāchaspati in the Tātparyyatīkā contends that mustard oil has not the flavour and smell characteristic of the true oils (sesamum, linseed *etc.*), and is classed with the latter by convention. Judged by the flavour test, A'mikshá (the casein substance formed by mixing milk-curd with hot boiled milk) is to be classed with milk substances. So also Takra, whey,—but Vājina, the thin fluid that is left after the Am'ikshá (casein substance) is separated, cannot be classed as milk. It may be added that the milks and curds as well as oils and fats derived from different species of vegetables or animals are supposed to differ in their ultimate structural arrangement and therefore in kind; but Vallabha thinks that the ghees (clarified butters) prepared from different kinds of milk are of the same kind; in other words, the milks and curds are 'polymeric', the ghees (clarified butters), 'isomeric', using these terms, as before, in a loose general sense..... वैचक्षण्यवत्तानां दोषद्वैत-
वाच्यत्वमिति । चक्षुः परितोषवैचक्षण्यं वैचक्षण्यं रसादि-

साकष्यादपि तु द्रव्यपद्विशेषः । Udayana, Kiranāvalī, पृथिवीनिरूपणम् । Vallabha notes that ghees do not differ in kind, as milks (and curds) do :—
अतो माद्विषयव्यादिदुग्धेषु दधित्वत् दृढादिषु जातिभेद-
एवास्त्वामिति चेन्न ।—Vallabha, Līlāvati. Compare Vāchaspati, II, 2, 65 :—आव्यतैलादीनां जातिस्तु गन्धेन वा रसेन वा व्यव्यते । अतएव न साधंपादीनां तैलत्वमस्ति । तद्व्यञ्जकयो-
र्गन्धरसयोरभावात् । भाक्तस्तु तैलव्यञ्जकीयः । क्षीरजातिरपि रसव्यञ्जकैव ।
अतएवाभिधायाः क्षीरत्वम् । न तु वाजिनस्य तदव्यञ्जकस्य रसभेदस्य
वाजिने अभावात् आमिधायां च भावात् ।

III. Mixtures like soups, solutions *etc* :—A soup is a physical mixture of a peculiar kind, from which evaporation ordinarily sets the water free (cf. Udayana's अनपतनुक्त *infra*). When meat is boiled in water, there is the application of heat, with chemical changes in the meat, but the combination of meat-particles and water-particles in the soup is only physical combination, and not a chemical one. It is of course not a true compound, neither is it a quasi-compound, like milk (in which the water-particles are 'energisers' of the Earth-particles). Milk, for example, retains its milky substance, when it coagulates or becomes solid, (this of course is also the case with mono-Bhautic substances whether elementary or compound, *e. g.* water, which becomes ice,) but the substance we call a soup or solution ceases to be a soup

or solution, the moment it solidifies. Uddyotakara notices gruel, baths, and lyes (alkaline solutions) as mixtures of this class (एतेन पापकाश्चिकविवेकावचारादयः प्रत्युक्ताः । Vārttika, Chap. I, A'hnika 1, Sūtra 14). यूषो हि नाम उत्तपन्नपाकजानां द्रव्याणां कालविशेषानुयुक्ते सति द्रव्यान्तरसंपृक्तानां पाकजीत्यसौ यः संयोगः स दूष इति । एतेन पापकाश्चिकविवेकावचारादयः प्रत्युक्ताः । Uddyotakara, Vārttika, Chap. I. A'hnika 1, Sūtra 14. *Vide* also Vāchaspati's comment : उत्तपन्नपाकजानां तैले सर्पिषि वा पिष्टमांसपिच्छावयवानां द्रव्यान्तरेण तोयेन संयुक्तानां पाकजीत्यसौ सत्यां न चासौ सहसा इत्युक्तं कालविशेषानुयुक्ते सतीति । स च संयोगमेद-एव तोयमांसयोर्नंतु अवयवो विजातीययोरनारम्भकत्वात् । नापि यूषजातीयं तोयसंयोगि द्रव्यं क्षीरजातीयमिवेति युक्तम् । तोयविरुद्धे काठिन्येऽपि क्षीरबुद्धिर्व्यपदेश्योक्तादवस्थात् । इह तु काठिन्ये न यूषबुद्धिर्व्यपदेशी इति सम्बन्धमेद एव तोयमांसयोर्दूष इति न्याय्यम् । स च अनुभवसिद्धः संयोगिव्यतिरिक्तः । Vāchaspati, Tātparyyatīkā, *ibid.* For salt and alkaline solutions, *vide* Kiranāvalī—यत् पुनरनुधिसिक्तुमेदेन चारादिरपि रसः पायसे उपलब्ध्यते स दक्षमूलकवागृह्येव पार्थिवद्रव्योपाधिकः । कथमन्यथा तस्यैव चनपीतमुक्तास्य रसो मधुर एव । Udayana, Kiranāvalī, जलनिष्पन्नम् ।

Chemical action and Heat :—The operation of heat is of course universally implied in chemical

colour, taste, smell etc., showing that there is chemical transformation, or subtle decomposition and recombination going on; and this is also the case with the rusting of the metals, which is a combustion due to the solar heat (सूर्यपाक) even as the conversion of food into chyle and of chyle into blood are instances of chemical action due to the internal animal heat (जठरान्न or जीव्य तेजः). But the kind of contact with heat-corpuscles, in other words, the kind of chemical action (पाक) which transforms colours is supposed to differ from that which transforms flavour (विस्फुल्लितः संकीर्ण) and पाक) and this last from that which produces a change of smell, or tactile quality. (पाको नाम विजातीयतेजः संकीर्णः । स च नानाजातीयः । उपजनको विजातीय-तेजः संकीर्णकद्वये च रसजनको विजातीयः । एवं अर्थाद्दी चपि तथा । एवं प्रकारेण निम्नलिखिताः पाकाः कार्यैर्लक्ष्येण कल्पिताः । तथाहि द्रव्यसुक्ष्मविज्ञानाद्दी द्रव्यद्रव्यविजातीयतेजः संकीर्णान् पूर्व-हरितरूपमात्रकान्तरक पीडादिसत्पक्षिः पूर्वहरतक कल्पेनामुक्तवान् । अचिन् पूर्वहरितरूपकल्पेऽपि रसपरान्वितं कते विजातीयतेजः संकीर्ण-कल्पकान्तरमात्रं पूर्वतनाकरतनामे मधुररसकान्तरमात्रं । तथाद्रूप-जनकापेक्षया रसजनको विस्फुल्ल एवं नमजनको विस्फुल्ल एकाग्रकार्थः कवरकवीरपरान्वितो चपि पूर्वमन्त्रमात्रे विजातीयपाक-व्याप्तं सुरमिजनकीवचनैः । एवं अर्जजनकीऽपि पाकव्याप्तं कठिन-

अर्जुनाग्नेः बहुल्यार्जुनभावात् । अतएव पार्थिवपरमाणूनामेकजातीयत्वेऽपि
 पाकमहिम्ना विजातीयद्रव्यान्तरानुभवः । यथा गीसुक्तदद्यादीनां अपर-
 माणूनां मध्ये दृष्टारम्भकपरमाणुषु विजातीयतेजःसंयोगवशात् पूर्व-
 रूपादिचतुष्टयनाम्ने तदनन्तरं दुग्धे घाहृजं रूपादिकं वर्तते
 तादृशरूपरसगन्धस्पर्शजनकाक्षेजःसंयोगा जायते । तदुत्तरं तादृशरूपादय-
 उत्तपद्यन्ते । तादृशरूपादिविशिष्टपरमाणुभिर्दुग्धवायुक्कमारभ्यते । ततः
 वायुकादिक्रमेण महादुग्धारम्भ इति । Nyāyabodhinī on
 Annam Bhatta's 'Tarkasangraha). Heat and light
 rays are supposed to consist of indefinitely small
 particles which dart forth or radiate in all directions
 rectilineally with a sort of conical dispersion and
 with inconceivable velocity. They may either (1)
 penetrate through inter-atomic (or inter-molecular)
 spaces as in cases of conduction of heat which when
 applied under the pot boils the water, or fries the
 paddy where there is no chemical action in the pot,
 no decomposition and recomposition of its atoms, no
 change in the molecular collocation ; or, as with light
 rays in cases of translucency or transparency
 (सञ्च्यता) penetrate through the inter-atomic spaces
 with Parispanda of the nature of deflection or
 refraction (तिर्यग्गमन, Udyotakara), in the same
 way as when fluids penetrate through porous bodies
 (तत्र परिचयः तिर्यग्गमनं परिचयः पात इति—Udyo-

takara, commenting on Vātsyāyana's परिचय-परिचयौ, Sūtra 47, A'hnika 1, Chap. III.) or (2) impinge on the atoms, and rebound back—which explains reflection (मूर्च्छन, किरणविचटन—Varāhamihira, रश्मिपरावर्तन—Vātsyāyana) or otherwise be obstructed by the atoms in their path, which would explain degrees of opacity, the casting of shadows, etc., all these operations being also physical, and unattended with decomposition and recombination or alteration of molecular grouping, or (3) lastly, strike the atoms in a peculiar way, so as to break up their grouping, transform the physico-chemical characters of the atoms, and again recombine them, all by means of continual impact with inconceivable velocity, an operation which explains all cases of chemical combination. (अचिन्त्यो हि तेजसो खाद्यवातिशयेन वेगातिशयः यत् प्राचीना अलक्ष्णवत्त्वानि एव भगवति मयूखमालिनि भवनीदरेषु आसीकृत्यभिमानो लौकिकानाम्। (Udyana, Kiranāvalī, तेजोनिरूपणम्—taken from Vāchaspati, Tātparyyatīkā, प्रत्यक्षचक्षुःश्रवणम्।) Cf. also (आद्युषं तेजः वेगवता सावितेन तेजसा न प्रतिहन्ते। Vāchaspati—वर्तिदेशे पिच्छितमपि तेजः प्रसर्पत् प्रासादीदरं व्याप्नोति। 'तत् कस्य हेतोः पृथग्यत्नात्। स्वभावतः प्रसरदपि न स्वपरिमाणादनुविधायिनं' प्रत्ययमाद्यते किं तु निषयमिदानीदनुविधायिनम्। *ibid.* Cf. कटिकावन्तरितीपक्षविरपि

प्रकाशनायका कटिकादीनां तेजोमतेषु निबन्धनायां प्रदीपनाया-
 दैवीपद्यः। Udayana, तैत्तिरीयसूत्रम्, in reply to the
 objection—इदि हि प्रायः गृहीतात् प्रविशामिना कटिकान्तेषु
 निष्काशनायं प्रदीपनायादिनां नाददीत तन्नादप्राप्तकारि तवी न
 तेजसम्। (Udayana, *ibid.*) Definition of सत्त्वता—
 द्रव्यान्तरात्मकद्रव्यसमवायः सत्त्वता। दृष्टवान्विधातः कायाव-
 षट्कटिकाकारिपद्यः। सत्त्वतादिषु च पापकस
 तेजसीप्रविशामात्। Uddyotakara, Chap. III, A'hnika
 1, Sūtra 38. चाद्विपरिणतः कटिकाकारितेऽपि दाक्षेयि-
 कात्। Sūtra 47, where Uddyotakara notes—कीड-
 नविधातः—यस्य द्रव्यसायना न सत्त्वते तस्य चत्वारस्यतेः
 चत्वारानामस्य कीडनित्यत्वः कीडनविधात इति। Vāchaspati
 explains यस्य द्रव्यस्य अर्जनकपादादिः चत्वारस्य न सत्त्वते
 पूर्वोक्तद्रव्यान्तरात्मकसंकीर्णनाशेन द्रव्यान्तरजनकसंकीर्णनाशनं सत्त्वते
 तस्य द्विषते तस्य द्रव्यस्य अर्जनकपादादिरूपानामस्य
 चत्वारस्यतेकीडनित्यत्वो बहुः कीडनविधातः। Cf. Vātsya-
 yana on Sūtra 47, A'hnika 1, Chap. III. On the
 other hand in chemical combination, यन्तःप्रवेशः
 क्त्वानीरमुनीयते। तेन वेगवता वस्त्रद्रव्येषु कीडनात् चवि-
 चातात् वा यव रवेषु क्षिप्वा, क्षिप्वाती विमानः, विमानात्
 चारककसंकीर्णविमानः *etc.*—Jayanta, Mañjarī, मूलपद्य-
 चूर्णपद्यः। For opacity, shadows, *etc.*, *vide* हावः इ
 तेजःपरमासीरावरकात् मूर्धन्यता परमाकुता तेजःपरमाकु-
 राभिवर्धे। यस्य च यस्य चावरणं तस्य चाद्विषि। विर-
 तेजःसत्त्वतीनि द्रव्यमुपकक्षाधि च्वादा प्रमिषीयते। अर्जनी

आद्योक्तैः कथं नोक्तिं तु तानि वक्तव्यं भवति । Uddyotakara, Chap. IV. A'hnika 2, Sūtra 25. For reflection, and its laws, I quote passages in my paper on Hindu Physics and Mechanics, to which the student of the history of Optics is referred.

Arrangement of atoms in Space :—The Nyāya conceives atomic magnitudes as Párimáñdalāya, a term which indicates a spherical shape. (निम्न परिमण्डलम्—परिमण्डलमेव पारिमाण्डलम्—Saṅkaramisra). To conceive position in space, Vāchaspati takes three axes, one proceeding from the point of sunrise in the horizon to that of sunset on any particular day ; (roughly speaking, from the East to the West) ;—a second bisecting this line at right angles on the horizontal plane, (roughly speaking, from the North to the South), and the third proceeding from the point of their section up to the meridian position of the sun on that day, (roughly speaking, up and down). The position of any point in Space, relatively to another point, may now be given by measuring distances along these three directions, i.e. by arranging in a numerical series the intervening points of contact, the less magnitude or distance being that which comes earlier in this series, and the greater that which comes later. The position of any single atom in Space with reference to another may be indicated in this

way with reference to the three axes. But this gives only a geometrical analysis of the conception of three-dimensioned Space, though it must be admitted in all fairness that by dint of clear thinking it anticipates in a rudimentary manner not only the foundations of solid (co-ordinate) geometry, but also of the geometry of position, and especially the conception of Space as a Manifold, which alone can serve as the basis of a generalisation comprehending all different possible kinds of geometry, Euclidean and non-Euclidean. (एकलेऽपि दिशः आदिष्वीदयदेशप्रत्यासन्नदेशसंयुक्ती

यः स इतरक्षादविप्रकटप्रदेशसंयोगात् परमाणोः पूर्वः एवमादि-
त्यात्मयदेशप्रत्यासन्नदेशसंयुक्ती यः स इतरक्षादविप्रकटप्रदेश-
संयोगात् परमाणोः पश्चिमः तौ च पूर्वपश्चिमी परमाणू
अपेक्ष्य यः सूर्योदयास्तमयदेशविप्रकटप्रदेशसंयोगः स मध्य-
वर्ती । एवमेतयोर्थौ तिर्यग्देशसम्बन्धिनौ मध्यस्थ आर्जवेन
व्यवस्थितौ पार्श्ववर्तिनौ तौ दक्षिणीतरी परमाणू । एवं
मध्यन्दिनवर्तिसूर्यसन्निकर्षविप्रकर्षौ अपेक्ष्य उपर्यधीमावौ
द्रष्टव्यः । संयुक्तसंयोगात्पल्लवसूत्रत्वे च सन्निकर्षविप्रकर्षौ पूर्व-
संस्थावच्छिन्नत्वं च अस्तत्वं परसंस्थावच्छिन्नत्वं च सूत्रकुम्भ ।
Vāchaspati, Tātparyyatīkā, Chap. IV. A'hnikā 2,
Sūtra 25.

The original physical arrangement of atoms is also given. Each atom is in contact with six other atoms, which gives a cubical arrangement. एवं

दिशोऽपि एकत्वा अपि संयोगा एव भागाः सीदयं परमाणोः
 षट्केन युगपद्वयोर्गो मूर्त्तत्वमात्रप्रयुक्तः न सावयवत्वप्रयुक्तः । *ibid.*
 Cf. also the objection in the Buddhist Kārikā.
 षट्केन युगपद्वयोर्गो परमाणोः षडंशता । षष्ठा समानदेशत्वे
 पिच्छः स्याद्व्युत्पन्नत्वः ॥ This is the typical primordial
 arrangement, and variations in the collocation
 of atoms and molecules (व्यूह, अवयवसन्निवेश), as
 we have seen, were conceived to account for
 the variety of isomeric modes of the same Bhūta,
 as well as of mono-Bhautic and poly-Bhautic
 compounds.

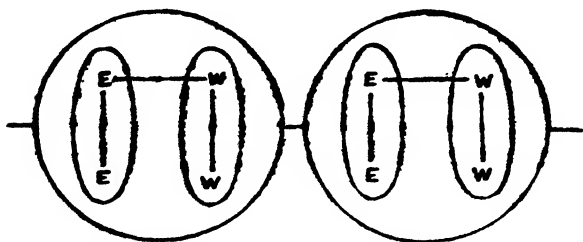
The molecular arrangement in the case of
 bi-Bhautic compounds is very peculiar. Two sub-
 stances, say Earth and Ap (water), form a quasi-
 compound, first, and each substance breaks up
 into atoms, one atom of Earth comes into contact
 with one of Ap. But the two do not form a binary
 molecule. Instead, this contact of heterogeneous
 atoms leads to a curious result. The atom of Earth
 combines with a neighbouring atom of its own class,
 and forms a binary molecule. Simultaneously
 the atom of Ap combines with another Ap-atom,
 and forms a binary molecule. Now the first binary
 molecule links on to the atom of Ap, and
 similarly the second binary molecule links
 on to the atom of Earth. The moment after,
 the two binary molecules take on the physico-

chemical characters of Earth and Ap respectively; and simultaneously with the assumption of these physico-chemical characters, the binary molecules enter into complex contact (संकीर्ण संकीर्ण). In all this process, work is done only in the first instant, in the contact of an atom of Earth with one of Ap—the resulting contacts, of atom with binary molecule and of the binary molecules with each other, involve no further expenditure of Energy. Thus we get a particle holding two binary molecules (of Earth and Ap respectively) in complex contact, and such particles continue to be formed. In this way the particles of the two substances arrange themselves, and the peculiarity of this molecular arrangement explains the resulting mixed or compound qualities of this class of quasi-compounds. (संकीर्णस्य संकीर्णः) उद्यमप्रमाणक

विरोधप्रक या निश्चितक कारकसंकीर्णकारकः कारका-
कारकसंकीर्णपूर्वकः कारकाकार्यप्रकः संकीर्णः ।.....एक-
कारक इतीत्यर्थः कथम् । यदा कारिकाप्रकीरणीः संकीर्ण
इति प्रत्येक कारिकाप्र कीर्णप्र प्रत्येक प्रत्येक च
प्रत्येक प्रत्येक प्रतीति मध्यमप्रकारे वाया संकीर्णप्रकारे कारिका-
प्रकारे इत्युक्ते प्रत्येकप्रकारे । यदी कथम् कारिका प्रत्येकप्रकारेः
कारकप्रकारपूर्वकप्रकारे कथामुक्तिः कथितेन कारिका प्रतीतिर-
कारकाकारकप्रकारे संकीर्णप्रकारे प्रतीतिप्रकाराकार्यप्रकारे संकीर्ण प्रत्येक-
प्रकारे । किं कारकम् । कारकसंकीर्णप्रकारे च कारकप्रकारे कारिका
प्रकारे संकीर्णप्रकारे इति प्रकः । कथः कारिका प्रत्येक कारकसंकीर्णप्रकारे

प्राचीन ऋषयः उवाचतः । चायमपि द्वायुगं द्वायुगं वीर्यमा दार्दिन्येति
(*Praastapáda-Bhásya*, दुचदने रंथीननिरुदधन् ।)

The whole process may be graphically represented as follows :—



E = an atom of Earth.

W = an atom of water (Ap).

E
|
E — a binary molecule
of Earth.

W
|
W — a binary molecule
of water (Ap).

Molecules of a bi-
Bhautic quasi-com-
pound;—graphic for-
mula of complex
contact.

I will conclude this account of ancient (and mediæval) Hindu chemistry with a note on the conception of molecular (atomic) motion, *Parispanda*, and the different varieties of such motion which were conceived to account for the physical phenomena of sound, light and heat. Any attempt to differentiate rigidly between Mechanics and

Physics on the one hand and Chemistry on the other at this primitive stage would be an idle affectation. My paper on Hindu Mechanics and Physics will give a detailed exposition in a separate treatise.

Parispanda :—Resolution of all physical action into motion :—

Parispanda sometimes stands for motion molar as well as molecular, but more often for the subtle motion of atoms or molecules. The radical meaning of the term is whirling or rotary motion, a circling motion, but it may also include simple harmonic motion (*e. g.* vibration). All action, operation, work (क्रिया व्यापार) is ultimately traced to this form of subtle motion lodged 'in the atoms or in the matter-stuff. The Vedānta, for example, speaks of a cosmic vibratory motion (सर्वलोक-परिस्पन्दनम्—Sāṅkara).—A'kāśa, in the Vedānta, as we have seen, is the first stadium in the evolution of Matter, which gives off Vāyu, which gives off Tejas, and so on ; but A'kāśa (Ether) itself passes through two stages before the emanation of the Sūkshmathūta Vāyu :—(1) the motionless ubiquitous primordial matter-stuff (answering to the Sāṅkhya Bhūtādi) called Purāṇam kham (पुराणं खं) and (2) a subtle integration, the pure unquintuplicated Sūkshmathūta called Vāyuram Kham

(वायुरं खं) (answersng to the Sāṅkhya Tanmātra stage). It is this subtile A'kāśa, in its Tanmātric integration, i. e. in the derivative form, which is subject to an incessant Parispanda. The gaseous stage of matter (the Vedāntic Vāyu) is indeed matter in a state of Parispandic motion (वायोः परिस्पन्दात्मकत्वात्—Sankara). So also the bio-motor and sensori-motor principles apart from the directive Intelligence of the Self (प्राचक्ष परिस्पन्दात्मकत्वादेव—यद्वैतम् सूखं सूक्ष्मं तत्सर्वं मनःस्पन्दितमात्रम्—Sankara). The Sāṅkhya also conceives this Parispanda to characterise every process and phenomenon of cosmic evolution (व्यक्तं सक्रियं परिस्पन्दवत्—Vāchaspati, Kaumudī). Bhutas, organisms, mental organs, as modes of Prakṛiti (considered apart from the Intelligence of Puruṣha) are all subject to this Parispanda उद्गादयो देह लज्जो देहान्तरं उत्पादयते इति तेषां परिस्पन्दः । रगैरप्यभ्यादोनां च परिस्पन्दः प्रसिद्ध एव ।—Vāchaspati on Kārikā 10). On the other hand, Prakṛiti as the Avyкта, the a-cosmic, the un-manifest ground, with resolution only of like to like (सदृशपरिचयान्), is devoid of all Parispandic motion (यद्यपि अव्यक्तास्त्रापि परिचयानव्यवस्था क्रिया, तथापि परिस्पन्दो नास्ति । *ibid.* on Kārikā 10). The Nyāya-Vaiśeṣika finds Parispanda in all

forms of matter, except A'kāśa which, in that system, is non-atomic and incapable of any change or activity (निष्क्रिय). But all atoms from those of Vāyu downwards, are in incessant motion. 'The world at bottom is an infinitude of continually whirling (or vibratory) particles (अनवरतपरिपन्थ-मानापरिमितपवनादिपरमाणवः—Raghunātha ;—compare also Udayana-Kusumāñjali, Stavaka V.—परमाणवः हि गतिशीलत्वात् पतनव्यपदेशाः पतन्तीति ।). All physical action consists in motion. The Nyāya-Vaiśeṣhika rejects force, power, operation (शक्ति) except as modes of motion. Jayanta indeed states : we do not acknowledge any mysterious power or operation, which the senses do not and cannot report to us. But this denial of Force (शक्ति) and of unperceived and unperceivable operation (अतीन्द्रियव्यापार) is put forward as a philosophical (epistemological and metaphysical) proposition to justify the Nyāya analysis of the causal *nexus* into mere invariable and unconditional antecedence among phenomena without productive power or efficiency अव्यवसायिहिरण्य निवृत्तपुरुषवर्तिता—Bhāṣā-Parichehḥeda). It is not of course intended to question the existence of Parispanda, which is of the nature of motion, and which, though subtile and therefore infra-sensible (सूक्ष्म and अनुभूतकृप, not अतीन्द्रिय), is the ultimate form of all physical

activity. (परिस्पन्द एव भौतिको व्यापारः करीष्यते । अतीन्द्रियस्तु व्यापारः नास्तीति ब्रूयते ।.....तस्मात् कारक-चक्रेषु चलता जगते फलम् । न पुनश्चलनादस्ती व्यापार-उपलभ्यते । Jayanta, Nyāya-Mañjarī, Ahnika I). The effect (no less than the action) is, in all cases of material causation, the resultant of the combined motions of the various (material and efficient) causes involved (e. g. in the case of पाक-समुदित-देवदादिसकलकारकनिकरपरिस्पन्द एव विशिष्टफलावच्छिन्नः पाक इत्युच्यते । ... अथ व्यापार एवैषः सर्व्वः संभूय साध्यते । किं फलेनापराहं वः तद्धि संभूय साध्ययाम् ।—Jayanta, Nyāya-mañjarī, A'hnika I).

But, in the Nyāya-Vaiseshika, though all action of matter on matter is thus resolved into motion, conscious activity is sharply distinguished from all forms of motion. as against the Sāṅkhya-Vedānta, which, as we have seen, considered every thing other than Intelligence, the Purusha or the transcendental Self, to arise in the course of cosmic Evolution, and therefore to be subject to Parispandic motion. (क्रियाविशेष इवायं व्यापारी ज्ञातुराकारः । स्पन्दान्तरकवर्द्धिर्भूतक्रियालक्षणाविलक्षणः ।—Quoted in Jayanta's Nyāya-mañjarī, A'hnika IV).

Santāna, i. e. Gati-santāna (including wave motion and current motion or convection) : Kampa santāna, Spandana, (vibration) :—Charaka notes

three kinds of *santánas*, serial motions, *viz.*, those of water, sound and light (जलसन्तान, शब्दसन्तान and अक्षिसन्तान). Chakrapáni points out that a wave of sound travels more rapidly than a wave of water, and much less rapidly than a ray of light. In Hindu Mechanics, a current of water (downward flow, खन्दन) is conceived to consist of particles moving in an uninterrupted series under the action of gravity and fluidity (गुरुत्व and द्रवत्व). A ray of light implies the rectilinear propagation of indefinitely minute corpuscles, in all directions, with inconceivable velocity, and a sort of conical dispersion (अचिन्त्यो हि वेगातिशयः तेजःप्रसरणं व्याप्नोति पृथ्वयत्नात् Uddyotakara—Váchaspati). A wave of water (वैचितरङ्ग) implies the transmission of vibratory motion in the water particles. (Cf. Jayanta—पतद्वचनपयोविन्दुसंदाहरणन्दनज्ञानात्, A'hnika II). A wave of sound is conceived by some on the analogy of a wave of water (वैचितरङ्गन्याय), only the air-waves (cf. the *Mímámsá*) or the sound-waves in and through the vehicle of air waves (cf. the *Nyáya-Vaiseshika*) travel by concentric circles not in one but in all planes. (N. B. this assumes transverse waves). Others hold that the air waves (cf. the *Vákya-padiya*) or the sound and air waves (cf. *Uddyotakara*) are propagated by the transmission of the vibration in all directions, leading to conjunction and disjunction of air-particles, so that the wave may be said to expand by alternate concentric

spherical layers of rarefaction and condensation (प्रचय) (N. B. this assumes longitudinal waves),—
 (कदम्बगीतकव्याय—cf. संयोगविभागो नैरन्तर्येण क्रियमाणाः
 शब्दमभिव्यञ्जन्ती नादशब्दवाचाः (Savara-Bhāshya 1—1—17)
 अभिघातेन हि प्रेरिता वायवः क्षिप्तानि वायुक्तराशि प्रति
 घावमानाः सर्व्वतोदिक्कान् संयोगविभागान् उत्पादयन्ति।—*ibid.*
 1—1—13). The Vākya-padīya describes articulate
 sounds (Varnas) and indeed all sounds (śabdas) as
 only forms of air set in motion, with rarefaction and
 condensation (प्रचय), and capable of variations
 of velocity and configuration (स्थानेष्वभिहतो वायुः शब्दं
 प्रतिपद्यते। तस्य कारणसामर्थ्यात् वेगप्रचयधर्षिणः। संनिपातात्
 विभज्यन्ते सारवत्योऽपि मूर्त्तयः—Vākya-padīya, Kānda
 I. Sloka 109) (*vide* my paper on Hindu Mechanics
 and Physics). (For the Hindu doctrine of scientific
 Method, *vide* Appendix; for certain interesting
 recipes of chemical technology, *vide* Addenda).

I had intended to conclude this survey of Hindu
 Physico-chemical science with a comparative esti-
 mate of the evolution of scientific ideas in the cul-
 ture-history (kultur-geschichte) of the Chinese, the
 Greeks and the Arabs, as an Essay in the historico-
 comparative method of investigation (*vide* the Intro-
 duction to my Comparative studies in Vaishnavism
 and Christianity for a correction of this method),
 but space forbids, and the reader too, I fancy.

The Date of Basaratnasamuchchaya.

While the present volume was about to issue from the press, Mr. T. G. Kāla, Editor of the Marhattā Journal "Samālochaka", sent us a critical notice of R. R. S. As there are some important historical facts brought to light and as the date of this work arrived at from quite independent sources tallies with that assigned by us (Vol. 1. Intro. LXXXIX), we make no apology for reproducing its substance in a condensed form.

Charpati or Charpatinātha of the Nātha school is mentioned in the 'R. R. S., (see VI, 58, Poona edition), as also king Singhana.

The Navanātha Saktisāra, a Marhattā work by Narahari Māla, gives some legendary information about this Charpatinātha and speaks of him as a contemporary of Matsyendranātha. On the left has

मत्स्येन्द्रनाथ

गोरक्षनाथ

मेमीनाथ

निष्ठतिनाथ

ज्ञानदेव

} been¹ given the geneology of the pupils of मत्स्येन्द्रनाथ. The last, ज्ञानदेव or ज्ञानेश्वर, was the celebrated Marhattā Saint and author of a commentary on the भगवद्गीता called ज्ञानेश्वरी.* It was written in Saka 1212,

i.e., A. D. 1290. So मत्स्येन्द्र and Charpatinātha must have lived at the *beginning of the thirteenth century A. D.*

*See the concluding portion of ज्ञानेश्वरी, a Marhattā work.

The R. R. S. which mentions the Siddha Char-pati must be therefore later than the first half of the thirteenth century A. D.

सिद्धचरित्र II (A.D. 1069)

सिद्धचरित्र I

महर्षि

सिद्धचरित्र (A D. 1191)

सिद्धचरित्र (A D. 1191-210)

सिद्धचरित्र II (A.D. 1210-1247)

Among the Yádava kings of Devagiri or Daulatabád, there were two kings by the name of Singhana. Taking the Singhana mentioned by R. R. S. to be the second, we are required to place the composition of the

work in the latter half of the 13th century. On the whole the R. R. S. may be safely taken to be a work written *about 1300 A. D.*

THE WEIGHT OF AIR.

(*By Principal B. N. Seal*).

Experiments were of course conducted for purposes of chemical operations in relation to the arts and manufactures, *e.g.*, metallurgy, dyeing, pharmacy, perfumery, cosmetics, horticulture, and the making of glass (lenses and mirrors of various kinds are mentioned, the spherical, oval—*गुच्छ* and *वर्तुल*, being well-known—Pliny indeed mentions that the best glass ever made was Indian glass). But of Experiment as an independent method of proof or discovery, the instances are rare. I may

note one interesting example in Udayana's *Kirānāvali*, relating to the weight of air. Udayana argues that air must be a distinct and independent *Bhūta*, for if air were made of the Earth-*Bhūta*, it would have weight, and it has none. To prove the absence of weight, he refers to an experiment. A small bladder made of a thin membrane, filled with air, will not cause a greater descent in the scale than the same bladder weighed empty. Hence the air possesses no weight. Then Udayana makes an interesting statement. It may be objected, he says by one who accepts the weight of air—that this argument is inconclusive. For a counter-experiment may be suggested. The balloon filled with smoke (or gas, धूम) rises in the air, whereas the air-filled balloon comes down. This would go to show that air has weight. Udayana replies that this would only show that both smoke (gas, धूम) and air have no weight. The Hindus appear to have been ignorant of the principle of Archimedes, at least as applied to gases. Vallabhāchārya in the *Līlāvātī* speaks of a peculiar resistance to sinking (or gravity) exercised by water, which explains the tendency in certain objects to float or to come up to the surface of the water but the description shows that he had no clear ideas on the subject. Cf. Udayana, *Kirānāvalī*, वायुनिष्कण्डम् । Cf. also Vallabhāchārya, *Līlāvātī*.

APPENDIX.

On the Scientific Method of the Hindus.

(BY PRINCIPAL BRAJENDRANATH SEAL.)

The Doctrine of Scientific Method :—A study of the Hindu Methodology of Science is absolutely essential to a right understanding of Hindu positive Science, its strength and its weakness, its range and its limitations. Apart from this rigorous Scientific Method, Hindu Chemistry, such as it is, would be all practical recipe, or all unverified speculation. This, however, would be a very inadequate and indeed erroneous view of this early achievement of the human mind. That the whole movement was genuinely and *positively* scientific, though arrested at an early stage, will appear from the following brief synopsis of the Hindu Methodology of Science.

Criterion or Test of Truth (after the Buddhists) :—The ultimate Criterion of Truth is found not in mere cognitive presentation, but in the correspondence between the cognitive and the practical activity of the self, which together are supposed to form the circuit of consciousness. That knowledge is valid which prompts an activity ending in fruition. Cf. the distinction between *सत्त्वादिज्ञान* and *विसत्त्वादिज्ञान* । Also compare, *प्रज्ञावन्तोऽर्थावतिपत्तौ प्रवृत्तिज्ञानव्याप्तौ चर्चवन् प्रज्ञावन्*—

Vātsyāyana). Truth, the Buddhists contend, is *not* self-evidence, *not* the agreement between ideas, *nor* the agreement of the idea with the reality beyond if any, for this cannot be attained direct, but the harmony of experience (सद्भाद), which is implied when the volitional reaction, that is prompted by a cognition and that completes the circuit of consciousness, meets with fruition, *i. e.*, realises its immediate end (cf. Śrīharsha, Khandana Khanda Khādyā on the relation of प्रमा to लोकाव्यवहार). This is the material aspect of Truth. The formal aspect is given in a principle which governs all presentations in consciousness, and which combines the three moments of Identity, non-Contradiction and Excluded Middle in every individual cognitive operation [तदुक्तं तत् परिच्छिनत्ति (identity) अन्यद् व्यवच्छिनत्ति (non-contradiction) तृतीय-प्रकाराभावं च सूचयति (excluded middle) इति एकप्रमाणा-व्यापारः—Jayanta, Nyāya-Manjarī, प्रमाणाद्वैविध्यवृत्तयाम्]

Perception :—The conditions of perception, and its range and limits, were carefully studied. The minima sensible (*e.g.*, the minimum visible, the Trasarenu, the just perceptible mote in the slanting sunbeam), the infra-sensible (अनुद्भूतरूप सूक्ष्म, sometimes termed अतीन्द्रिय the obscured (अभिभूत, *e.g.*, a meteor in the mid-day blaze), and the potential (अनुद्भूतवृत्ति), are distinguished; but finer instruments of measurement were wanting, and this was a principal cause of arrested progress. It may be noted that the measurement of the relative pitch of

musical tones was remarkably accurate and original (*vide* my Paper on Hindu Mechanics and Physics).

Observation (दर्शन—Vāchaspati and Udayana) :—The entire apparatus of scientific method proceeded on the basis of observed instances carefully analysed and sifted. This was the source of the physico-chemical theories and classifications, but in Anatomy, the Hindus went one step further; they practised dissection on dead bodies for purposes of demonstration. Ingenious directions are given, *e.g.*, the body must be first disembowelled and wrapped round with the kusa and other grasses, then kept immersed in still water for seven days, after which the medical student should proceed to remove the layers of the skin with a carefully prepared brush made of the fresh elastic fibres of green bamboos;—which will enable the tissues, vessels and ducts to be observed. *Post-mortem* operations as well as major operations in obstetric surgery (the extraction of the fœtus, etc.) were availed of for embryological observations (*e.g.*, it is stated as a result of observation that the rudiments of the head and the limbs begin to appear in the fœtus in the third month, and are developed in the fourth; the bones, ligaments, nails, hair, etc. becoming distinct in the sixth);—and also embryological theories, *e.g.*, the indication of sexual character in the second month by the shape of the fœtus, the shape of a *round* joint indicating the male sex, and an

elongated shape as of a muscle the female sex (cf. Charaka, Sūtrasthāna, Chap. IV,— विलीयि नास्ति चनः सन्त्यस्यते पिच्छं वेद्यार्द्धं वा । तत्र चनः पिच्छः पुरुषः स्त्री वेद्यी चर्मुदं नपुंसकम् । Chakrapāṇi notes : चनः कठिनः । पिच्छो सन्त्याकारः । वेद्यी दीर्घमांसवेद्याकारः । चर्मुदं वर्तुलीयतम् loc. cit.) In Phonetics (as in the Prātisākhya, circa 600 B. C.), in Descriptive and Analytical Grammar (as in Pāṇini), and in some important respects in Comparative Grammar (as in Chanda's and Hemachandra's Grammars of the Prākṛita Dialects), the observation was precise, minute and thoroughly scientific. This was also the case in Materia Medica, and in Therapeutics, especially the symptomology of diseases. In Meteorology, the Hindus used the rain-guage in their weather forecasts for the year, made careful observations of the different kinds of clouds and other atmospheric phenomena (e. g., they give the heights of the clouds, the distance from which lightning is ordinarily visible, or the thunder is heard, the area of disturbance of different earth-quakes, the height to which the terrestrial atmosphere extends, etc., vide Varāhamihira, Śrīpati, and the authorities quoted by Utpala). In Astronomy, the observation was, generally speaking, very defective as in the determination of the solar and the planetary elements, and this was probably due to the lack of practical interest, but the determination of the lunar constants entering into the calculation of lunar periods and eclipses, matters in

which the Hindus had a practical ceremonial interest, reached a remarkable degree of approximation (much above Græco-Arab computations) to the figures in Laplace's Tables, which can only be explained by the circumstance that in the case of these constants the Hindus carried out for more than a thousand years a systematic process of verification and correction by comparison of the computed with the observed results (like the navigator's correction of the course of the ship at sea), a process which was termed *दृग्गच्छितैश्च*. In Zoology, the enumeration of the species of Vermes, Insecta, Reptilia, Batrachia, Aves, etc., makes a fair beginning, but the classification proceeds on external characters and habits of life, and not on an anatomical basis. In Botany, the observation was mainly in the interests of Materia Medica, and the classification was as superficial as possible. (*Vide* my paper on the Hindu Classification of Plants and Animals).

Experiments :—Experiments were of course conducted for purposes of chemical operations in relation to the arts and manufactures, *e. g.*, Metallurgy, Pharmacy, Dyeing, Perfumery and Cosmetics, Horticulture, the making and polishing of glass (lenses and mirrors of various kinds are mentioned, the spherical and oval *शुक्ल* and *वर्तुल*, being well-known—Pliny indeed mentions that the best glass ever made was Indian glass). And the

results of such experiments were freely drawn upon for building up scientific hypotheses and generalisations. But of experiment as an *independent* method of proof or discovery, the instances recorded in books are rare. I may note one interesting example in Udayana's Kiranāvali, relating to the weight of air. Udayana argues that air must be a distinct and independent Bhuta, for if air were a form of the Earth-Bhuta, it would have weight, and it has none. To prove the absence of weight, he refers to an experiment. A small bladder made of a thin membrane, filled with air, will not cause a greater descent in the scale than the same bladder weighed empty. Hence the air possesses no weight. Then Udayana makes an interesting statement. It may be objected, he says, by one who accepts the weight of air—that this argument is inconclusive. For a counter-experiment may be suggested. The balloon filled with smoke (or gas, धूम), rises in the air, whereas the air-filled balloon comes down. This would go to show that air has weight. Udayana replies that this would only show that both smoke (or gas, धूम) and air have no weight. The Hindus appear to have been ignorant of the principle of Archimedes. Vallabhāchāryya in the Līlāvati, it is true, speaks of a peculiar resistance to sinking (or gravity) exercised by water, which explains the tendency in certain objects to float

or to come up to the surface of the water, but the description shows that he had no clear ideas on the subject.

Mathuránátha, again, states that the determination of the degree of purity (the carat) of gold by rubbing against the assaying stone and observing the character of the yellowish streak against the black smooth background, is only an indirect means of ascertaining weight (गुरुत्ववैलक्षण्य lit. specific gravity) —which seems to suggest that there was a more direct means of arriving at the latter. Probably this refers to the common Indian method of comparing the lengths and weights of wires of uniform thickness that can be formed by drawing different pieces of gold through the same diamond bore. I think it may be regarded as fairly certain that the Hindus were ignorant of Archimedes's discovery, an ignorance which, at any rate, they could not have well borrowed from the Greeks, no more than they could have thus borrowed their knowledge of things unknown to the Greeks themselves. [Cf. Udayana, Kiranāvali :—

वायुनिरूपणम्, किं च (वायोः) पृथिवीति गुरुत्वमपि स्यात् । न च पवनापूरितस्य चर्चस्पृष्टकादिः अपूरणदशातः अधिकं अवगमनम् । उन्नीय-
माणस्य धूमापूरितेन इदम् अनैकान्तिकं इति चेत् । न । अलं धूमदशायां ।
तत्रापि गरिमविशेषहेतोरवनतिविशेषस्य अप्रतीतिः ।—cf. Vallabbhā-
chāryya, Līlāvatī—गुरुत्वविशेषेऽपि पाषाणाणां प्रवृत्तिषु मज्जनो-
न्मज्जन नियमवत् अदृष्टहेतुवत्ता स्यादपि पतनीतृपतन-नियमो भविष्यतीति ।

येत् न । जलप्रयोगनं जलेन चारुं पतनप्रतिबन्ध उन्मूलनं एतच्च
जलस्य योगस्य कस्यचिदेव पतनप्रतिबन्धसामर्थ्यात् । इष्टं हि तु कस्यैव जलजन्य
उन्मूलनञ्च]—cf. Mathuránátha, सन्निकर्षवाहरकस्य on Gan-
gees's Tattvachintámani—तस्य (निष्करोपलस्य) न सुवर्च-
पोताभिव्यक्तकालं किन्तु पीतवारा शुद्धवर्णस्य च व्यक्तकालमेव तस्य ।

Fallacies of Observation—Mal-observation and Non-observation :—These were carefully studied in relation to errors of observation, and Hallucination (भ्रम, अध्यास, चारीप)—which were ascribed to three causes :—(a) Doshā, दोष, defect of sense organ, as of the eye in jaundice, or of the skin in certain forms of leprosy (leading to tactile insensibility, cf. Susruta) or defect of necessary stimulus, e.g., too faint light, or undue distance or nearness, in vision ; (b) Samprayoga, समप्रयोग, presentation of a part or an aspect instead of the whole.; and (c) Sanskāra, संस्कार, the disturbing influence of mental predisposition, e.g., expectation, memory, habit, prejudice, etc.

The Doctrine of Inference :—Anumāna (Inference) is the process of ascertaining, not by perception or direct observation, but through the instrumentality or medium of a mark, that a thing possesses a certain character. Inference is therefore based on the establishment of an invariable concomitance (Vyāpti, व्याप्ति) between the mark, and the character inferred. The Hindu Inference (Anumāna) is therefore neither merely formal nor merely material, but a combined Formal-Material

Deductive-Inductive Process. It is neither the Aristotelian Syllogism (Formal-Deductive Process), nor Mill's Induction (Material-Inductive Process), but the real inference which must combine formal validity with material truth, inductive generalisation with deductive particularisation.

An inference admits of a rigorous formal statement,—in the shape of five propositions, for dialectical purposes (*i.e.*, in demonstrating to others), or of three propositions when the inference is for one-self (स्वार्थानुमान):—(1) the probandum, the statement of the proposition to be established (प्रतिज्ञा, साध्यनिर्देश, *e.g.*, yonder mountain is fiery (say, an active volcano); (2) the reason, the ascription of the mark (हेतु, लिङ्गव्यपदेश),—*e.g.*, for it smokes; (3) now, the general proposition, stating the invariable concomitance which is the ground of the inference,—clenched by an example bringing home the responsibility of the reasoner to establish a real relation, *e.g.*, whatever smokes is fiery, as an oven; (उदाहरण);—(4) next, the application, the ascertainment of the existence of the mark in the present case (उपपत्ति) *e.g.*, yonder mountain smokes;—(5) finally, the conclusion, the probandum proved (निगमन), *e.g.*, yonder mountain is fiery.

1. Yonder mountain is fiery.
2. For it smokes.
3. Whatever smokes is fiery, as an oven.

4. Yonder mountain does smoke.

5. Therefore, yonder mountain is fiery.

For inference for oneself, only the first three or the last three propositions, are held to be sufficient.

The Hindu Anumāna, it will be seen, anticipates J. S. Mill's analysis of the syllogism as a material inference, but is more comprehensive;—for the Hindu Udāharana, the third or general proposition with an example, combines and harmonises Mill's view of the major premise as a brief memorandum of like instances already observed, fortified by a recommendation to extend its application to unobserved cases, with the Aristotelian view of it as a universal proposition which is the formal ground of the inference. This Formal-Material Deductive-Inductive process thus turns on one thing—the establishment of the invariable concomitance (व्याप्ति) between the mark and the character inferred,—in other words, an inductive generalisation. The question is—what is our warrant for taking the leap from the observed to unobserved cases? Under what conditions are we justified to assert a Universal Real Proposition on the basis of our necessarily limited observation?

The Chārvāka view:—Among the Chārvākas there were two classes, the cruder school of materialists who accepted perception (प्रत्यक्ष) as a valid source of knowledge, as well as the reality of

Natural Law (स्वभाव), and the finer school of sceptics, who impugned all kinds of knowledge, immediate as well as mediate, and all evidence, Preception as well as Inference, *vide* Jayanta's reference in the Nyāya-Manjarī to सुशिक्षितचार्याः; also चार्याकथंतेषु अथातस्तत्त्वं व्याख्यास्याम इति प्रतिज्ञाय प्रमाणप्रमेयसंख्यालक्षण-नियमाश्रयकारणोक्तमेव व्याख्यातवान्—A'hnika I, Manjarī.

The Chārvākas hold that the principle of causality, which the Buddhists assume to be a ground of an induction (व्याप्ति) is itself an induction (a case of Vyāpti), which amount to reasoning in a circle (चक्रक); that every inference is based on an unconditional invariable concomitance which itself must be inferred. as universal propositions cannot be established by our limited preceptions. and thus there is a regressus ad infinitum (अनादि परस्पर); and that the nexus between cause and effect, or between the sign and the thing signified (e.g., smoke and fire) is only a mental step or subjective association based on former perception, a mental step which by accident is found justified by the result in a number of cases.

The Buddhists—their Analysis and Vindication of Inference :—The Buddhists, however, take their stand on the principle of the Uniformity of Nature (प्रतिबन्ध, स्वभाव प्रतिबन्ध, Nyaya-Vindu). This uniformity, for scientific purposes, has to be divided into two different relations,—(1) the uniformity of succession in the relation of cause and effect, e.g.,

of smoke to fire (कार्यकारणभाव, तदुत्पत्ति, Nyaya-Vindu); (2) the uniformity of co-existence (in the form of co-inherence in the same substrate) in the relation of genus and species, *e.g.*, the relation of invariable concomitance expressed in the proposition,—all Sinsapās are trees,—which is not a relation of causality, but of co-existence or co-inherence in the same substrate (*i.e.*, the co-inherence of the generic qualities of a tree with the specific characters of a Sisu tree, in this particular individual before me, a Sisu tree),—a relation which may be termed essential identity (तादात्म्या, स्वभाव—Nyaya-Vindu). To these two, the Buddhists add a third ground of inference, non-perception of the perceptible (अनुपपत्ति, दृष्ट्यानुपपत्ति), which is employed in inferring the absence (प्रतिषेध) of a thing from the non-perception of something else. In all cases of inference based on the Uniformity of Nature, the relation is that of inseparableness or non-disjunction between the mark and the character inferred. The question is—how is this inseparableness (अविनाभाव) ascertained, and what is the warrant of our belief in it, in these cases?

Ascertainment of Inseparableness or Non-disjunction: Buddhist Account:—First take the case of causation. The cause is the invariable antecedent of the effect. What is meant is that the specific effect (with all the distinctive and relevant accompaniments, कार्यविशेष) is invariably preceded by a

specific cause (कारणविशेष). It is not that clouds always lead to rain, or that floods in the river valley always imply rain in the hills higher up. But this particular conjunction of antecedent circumstances (e.g. the appearance of a particular kind of clouds accompanied with flashes of lightning, the roll of thunder and flights of Valákās—driven by the wind from a particular quarter of the horizon, and ascending in black masses, etc.) is as a rule the precursor of a particular assemblage of rain effects (rain with particular accompaniments). Again, this particular kind of flood (overflowing of the river banks accompanied with muddy discoloration of the water, rapid currents, the bearing down of tree trunks, etc.) is always preceded by rain in the hills higher up (though, no doubt, other case of floods in a river may be due to a breach in an embankment or the melting of the snows). In other words, the Buddhists (and the earlier Nyāya Schools) avoid the difficulty arising from the plurality of causes by taking into consideration the accompanying phenomena, which, if properly marked, would always point to a specific cause of a specific effect.

I quote Nyāya authorities, but this device to obviate the plurality of causes is common to the early Nyāya and the Buddhistic systems.

पूर्ववत् । यच्च कारणेन कार्यमनुमीयते । उदाहरणम्—

मेघोन्नत्या भविष्यति उडिरिति कारणेन कार्यमनुमानम् । कथं

पुनरस्य प्रयोगः । उटिमन्तः एते मेघाः गन्धौरध्वनिवत्त्वे सति बहुबलाका-
वत्त्वे सति अचिरप्रभावत्वे सति उत्पत्तिमत्तात् उटिमन्त्रे घवत् ।

शिववत् (यत्र कार्येण कारणमनुमीयते)—उदाहरणम्—

उपरिउटिमद्देशसम्बन्धिनी नदीस्तीतः शीघ्रत्वे सति पूर्णफलकाष्ठादि-
बद्धनवत्वे सति पूर्णत्वात् पूर्णउटिमन्नदीवदिति । (Uddyotakāra,
Chap I. A'hnikā 1, Sūtra 5). Vāchaspati puts this
clearly :—यद्यपि कारणमात्रे व्यभिचरति कार्योत्पादं तथापि यादृशं
न व्यभिचरति तच्च निपुणेन प्रतिपत्ता भवितव्यम् । अन्यथा धूममात्रमपि वज्र-
मत्ता व्यभिचरतीति न धूमविशेषो गमको भवेत् । In other words,
a single condition called a cause is not invariably
succeeded by the effect, nor does the effect
phenomenon in general point to any particular
cause as antecedent, for there may be a plurality of
causes of a general effect. The skilful observer
will therefore select the full complement of
causal conditions, which is invariably succeeded by
the effect,—and also the specific effect (e.g., धूमविशेष)
which points to a specific causal antecedent.
Compare also Jayanta :—we infer an effect from a
specific assemblage of causes—न च कारणमात्रस्य हेतुत्वं दूमी
दीमास्य व्यभिचारः स्यात् । अपि च विशिष्टमेव कारणं हेतुः । न च
कारणविशेषो दुरवगमः । गन्धौरगर्जितारन्ध्रनिभिन्नगिरिगङ्गराः शीतल-
गवलव्यासतमालमलिनस्त्रिषः...उटिं व्यभिचरन्तीह मेव प्रायः पयोमुचः ।
अनभ्युपगमे चैवमनुमानस्य जीवितम् । न स्याद्धूमविशेषाणामपि कोटुम-
न्नक्तिः । Similarly we infer a specific cause from
a specific assemblage of effects :—शिववदिति यत्र कार्येण

कारणमनुमीयते यथा नदीपूरैश्च उपरितने देशे दृष्टिरिति । दृष्टिमत्-
पृष्ठदेशश्च दृष्टा इयं नदी फेनिलकलुषत्वादिविशिष्टपूरोपेतत्वात् । यत्तु
सेतुमङ्गलिनविलयनादिनापि नदीपूरोपपत्तिर्दृष्टा इति तत्रापि 'सञ्चते—

प्रमातुरपराधीऽयं विशेषं यो न पश्यति ।

नानुमानस्य दोषोऽस्ति प्रमेयाव्यभिचारिणः ॥

(Nyāya-Manjarī, A'hnikā 2, on Gotama Sūtra
5, A'hnikā 1, Chap I.)

A specific assemblage of causes, therefore, has only one specific assemblage of effects, and *vice versa*. Of course, the observer is to find out the essential or relevant features (as distinguished from the irrelevant ones) which, being included, will enable him to specify the particular cause of the particular effect.

Now this being premised to be the exact meaning of the inseparableness or non-disjunction in the case of cause and effect, we come to the question with which we started—how is this relation to be ascertained or established between two phenomena or assemblages of phenomena ? Obviously, mere observtion of their agreement in presence (सन्ध्य) and their agreement in absence (व्यतिरेक) is no help in the matter. Take a concrete example. The ass is customarily employed to bring the fuel with which fire is lighted. In a hundred cases you have observed the ass among the antecedents of smoke. In a hundred cases you may have observed that when there is no ass, there is no smoke. This is no

warrant for concluding a relation of cause and effect between an ass and smoke. It may be that you happen to have never observed smoke without an antecedent ass, or an ass without smoke following. Even this is of no avail. It is not agreement (unbroken and uniform though it be) in presence, or in absence, or in both, that can settle the matter. There is one and only one way of ascertaining the causal relation. Suppose *A* with certain accompaniments is found to precede *B* immediately. Now if *A* disappearing, *B* disappears, even though all other antecedents remain and there is no other change in the case, then and then only can the causal relation be ascertained. It is not a mere table of positive instances or negative instances (अदर्शनान्न न दर्शनात्);—it is this method which we may term the Method of Subtraction (the Method of Difference in its negative aspect) that is the only exact and rigorous scientific Method. Such was the statement of the earlier Buddhists (cf. Uddyotakāra's and Vāchaspati's report of the Buddhist Doctrine of Inference—स हि प्रतिबन्धी न दर्शनमात्रावस्यः ।

तस्मात् तादात्म्यातदुत्पत्तिनिवन्धनः एव प्रतिबन्धः । यदाह कार्यकारण-
भावाद्वा स्वभावाद्वा नियामकात् । अविनाभावानियमोऽदर्शनान्न न दर्शनात्
—a Buddhist Kārikā quoted in Vāchaspati, Udayana,
Śrīharsha, Mādhava, etc.)—कार्यकारणभावश्च इदम्—अस्मिन्
सति भवति—सत्सु अपि तदन्वेषु अस्मिन्नसति न भवति—एवमाकारः ।
न अन्यथ्यतिरेकाभ्यामतिरिच्यते ।... (एवं तादात्म्यामपि विपर्ययं बाधक

प्रमाणोपपत्त्या निश्चेदव्ययम् ।...तस्मात् तादात्म्यात्तदुत्पत्तिभ्यामेव प्रतिबन्धो
 नान्यतः ।—Vāchaspati, Tātparyyatīkā, Chap I, A'hnikā
 1, Sutra 5, अनुमानलक्षणम्—व्याप्तिरहीपायः)

But the canon in this form is not sufficiently safe-guarded against possible abuse. Two points have to be emphasised :—(1) It must be carefully observed that no other condition is changed, (2) that the appearance and disappearance of *A* must immediately precede the appearance and disappearance of *B*. The definition of a cause is based on two fundamental characters, (1) the unconditional invariableness of the antecedence, and (2) the immediateness of the antecedence. The canon of the Method of Difference must therefore be stated in such a form as to emphasise each of these aspects. And one main difficulty in the practical application of the canon is that along with the introduction or sublation of an antecedent, some other phenomenon may be introduced or subluted unobserved. As a safe-guard against this radical vitiation of the Method, the later Buddhists formulated the canon of a modified Method, termed the Panchakārani, a Joint Method of Difference, which combines the positive and the negative Methods of Difference (the Method of Addition and the Method of Subtraction) in a series of five steps, and which equally emphasises the unconditionality and the immediateness of the antecedence as essential moments of the causal relation. This is

neither agreement in presence, nor agreement in presence as well as absence (the foundation of J. S. Mill's Joint Method of Agreement), but the Joint Method of Difference. The Panchakārani runs thus :—

The following changes being observed, everything else remaining constant, the relation of cause and effect is rigorously established :—

First step—The 'cause' and the 'effect' phenomena are both unperceived.

Second step—Then the 'cause' phenomenon is perceived.

Third step—Then in immediate succession, the 'effect' phenomenon is perceived.

Fourth step—Then the 'cause' phenomenon is sublated or disappears.

Fifth step—Then in immediate succession, the 'effect' phenomenon disappears.

Throughout, of course, it is assumed that the other circumstances remain the same (at least the relevant or material circumstances).

This Panchakārani, the Joint Method of Difference, has some advantages over J. S. Mill's Method of Difference, or what is identical therewith, the earlier Buddhist Method; and the form of the canon bringing out in prominent relief the unconditionality and the immediateness of the antecedence, is as superior from a theoretical point of view to J. S. Mills's canon,

and is as much more consonant than the latter to the practice of every experimenter, as the Hindu analysis of Anumāna as a Formal-Material Deductive-Inductive Inference is more comprehensive and more scientific than Aristotle's or Mill's analysis of the Syllogism (or Mediate Inference).

But even the Panchakārani is no sufficient answer to the question with which we started. The Panchakārani is only a method ; it shows only how in a particular case the relation of cause and effect is to be established (प्रतिबन्धद्वयीपाय). But we want more than this—we require a warrant for the process. The Buddhists therefore supply the following proof of the Method :—Doubt is legitimate, but there is a limit to doubt. When doubt lands you in an unsettlement of a fundamental ground of practice, and would thus annul all practical exercise of the will, the doubt must cease ; else the doubt would be suicidal or sophistical. In this particular case, when the Panchakārani is satisfied, the antecedent in question must be the cause, for there is no other antecedent to serve as cause ; the proof is indirect but rigid. If this be not the cause, there is no cause of the phenomenon. It was not, and it begins to be, without a cause ; which would be a contradiction of the rational ground of all practice, for all volitional activity proceeds by implication on the principle of causality. If things could happen

without a cause, all our motives to action would be baffled. The link between a presentation and the instinctive volitional reaction would snap, and the circuit of consciousness would be left incomplete. In fact, the Buddhists go further; they hold causal efficiency (कार्त्तिक्य) to be of the essence of empirical (relative) Reality. The proof of the Joint Method of Difference, then, lies in a strict application of the principle of causality in its negative form (viz., there can be no phenomenon without a cause) and the truth of this last is guaranteed by the same ultimate criterion of empirical (relative) Reality as the truth of Perception itself, viz., the correspondence between the rational and the practical activity of the self.

But invariable concomitance (or non-disjunction), the Buddhists argue, has another form, *e. g.*, the relation of the genus to the species. We may have perceived a hundred instances of the association of certain characters with certain others; we may also have never perceived the former when the latter are absent; but this would not enable us to generalise and establish invariable and unconditional co-existence. We must be first satisfied that there is identity of essence (तादात्म्य स्वभाव). It is only when we perceive that the characters of a Sinsapá are co-inherent with the generic characters of a tree in the same individual object (a Sinsapá tree before me), and when we further

perceive that the characters are held together by the relation of identity of essence, that we can say that all Sinsapás are trees. For as there is identity of essence, a Sinsapá would not be a Sinsapá. if it were not a tree. It would lose its self-identity which is a contradiction. Hence the relation of identity of essence (तादात्म्य स्वभाव), as in the relation of the species to the genus, is the sole ground for establishing uniformity of co-existence (प्रतिबन्ध, स्वभावप्रतिबन्ध).

(For the Buddhist Method of Induction, in its later form, the Panchakárani, vide Sarvadarsana Sangraha—Buddhist reply to the Chárváka attack on Inference :—

यदभ्यधायि अविनाभावो दुर्बोध इति तदसाधौयः। तादात्म्यतदुत्पत्तिभ्यामविनाभावस्य सुज्ञानत्वात्। तदुक्तं—कार्यकारणभावात् वा स्वभावात् वा नियामकात्। अविनाभावनियमोऽदर्शनात् न दर्शनात्। As for the Nyáya view अन्वयव्यतिरेकी अविनाभावनिश्चायकौ इति।—the Buddhist objects—ननु पक्षे साध्यसाधनयोरव्यभिचारो दुरवधारणः भवेत्। भूते, भविष्यति, वर्तमाने अनुपलभ्यमाने च व्यभिचारः शङ्काया अनिवारणात्।—the Nyáya retorts ननु तथाविचक्ष्यस्ते तावकीऽपि मते व्यभिचारशङ्का दुष्परिहारा इति।—the Buddhist answers—मेवं बोधः, विनापि कारणं कार्यमुत्पद्यताम् इत्येवं-विधायाः शङ्कायाः व्याघातावधिकतया निवृत्तत्वात्। तदेव हि आशङ्क्यत यच्चिन्नाशङ्कमाने व्याघातादयः नावतरियुः। तदुक्तं व्याघातावधिराशङ्का इति। तथात् तदुत्पत्तिनिश्चयेन अविनाभावो निश्चीयते। तदुत्पत्तिनिश्चयश्च कार्यहेतोः प्रत्यक्षोपलब्धानुपलब्धपक्षकनिवन्धनः।

कार्यस्य उत्पत्तेः प्रागनुपलब्धः, कारणीपक्षस्ये सति उपलब्धः, उपलब्धस्य पश्चात् कारणागुपलब्धात् अनुपलब्धः इति पञ्चकारणा लून-लूनपञ्चमीः कार्यकारणभावः निश्चीयते । तथा तादात्म्यानिश्चीय अपि अविनाभावः निश्चीयते । यदि शिंशपा वृक्षत्वम् अतिपतेत् स्वात्मानमेव जज्ञात् इति विपक्षे बाधकप्रवृत्तेः । अप्रवृत्ते तु बाधके भूयः सङ्गभावीपक्षस्येऽपि व्यभिचारप्रवृत्त्याः की निवारयिता । शिंशपावृक्षयोश्च तादात्म्यानिश्चयः वृक्षीयं शिंशपा इति सामानाधिकरण्यावस्थात् उपपद्यते । तस्मात् कार्यात्मानौ कारणम् आत्मानम् अनुमापयत इति सिद्धम् । Sarvadarsana Sangraha, Bauddha-Darsanam Vide also Sridhara Kandali.

The Nyāya Doctrine of Inference :—The Nyāya easily demolishes the Buddhist contention about identity of essence. The Nyāya writers, being realists, do not impugn the reality of the genus (जाति) like the nominalists or the nominalistic conceptualists ; but they point out that the inseparableness (or non-disjunction) in such cases can only be established by the experience of unbroken uniformity (व्यभिचारित्वं i.e., by व्यभिचयतिरिक्तौ, दर्शनादर्शने). Uniform agreement in presence with uniform agreement in absence,—not the mysterious identity of essence irresistibly perceived in any individual case or cases—is the only basis for constituting genera and species in Natural Classification. Indeed some of the later Nyāya writers point out that individuals do not always possess in Nature all the characters that go to form the definition of the class to which they are referred.

Similarly, as regards the relation of cause and effect, a *nexus* is sometimes fancied to be perceived, a power in the cause to produce the effect (शक्ति), or an ultimate form (जाति सौक्ष्मा), which is supposed to be present, whenever the effect (quality or substance) is produced (cf. Bacon's view of the 'Forms' of Simple Qualities). All this is neither a matter of observation nor of legitimate hypothesis. There is nothing except the invariable time-relation (antecedence and sequence) between the cause and the effect. But the mere invariableness of an antecedent does not suffice to constitute it the cause of what succeeds; it must be an unconditional antecedent as well (अन्यथासिद्धिमुन्वय नियतपूर्व-वर्जिता, being the definition of कार्यकारणभाव). For example, the essential or adventitious accompaniments of an invariable antecedent, may also be invariable antecedents, but they are not unconditional but only collateral and indirect, in other words their antecedence is conditional on something else (न स्वातन्त्र्ये). The potter's stick is an unconditional invariable antecedent of the jar, but the colour of a stick, or its texture or size or any other accompaniment or accident, which does not contribute to the work done (so far as we are considering it) is not an unconditional antecedent, and must not therefore be regarded as a cause. Similarly, the co-effects of the invariable antecedents, or what enters into the production of these

co-effects, may themselves be invariable antecedents but they are not unconditional, being themselves conditioned by those of the antecedents of which they are effects. For example, the sound produced by the stick, or by the potter's wheel, invariably precedes the jar, but it is a co-effect,—and A'kása (ether) as the substrate, and Váyu (air) as the vehicle, of the sound, enter into the production of this co effect, but these are not 'unconditional' antecedents, and must therefore be rejected in an enumeration of conditions or causes of the jar. Again, the conditions of the conditions, the invariable antecedents of the invariable antecedents, are not unconditional. The potter's father is an invariable antecedent of the potter who is an invariable antecedent of the jar, but the potter's father does not stand in a causal relation to the potter's handiwork. In fact, the antecedence must not only be unconditionally invariable, but must also be immediate (अव्यवहितपूर्वकालावच्छेदेन कार्यदेशे सत्त्वम्). Finally, all seemingly invariable antecedents which may be dispensed with or left out, are *ipso facto* not unconditional, and cannot therefore be regarded as causal conditions ; in short, nothing that is unnecessary is unconditional ; for this class, *vide* Visvanátha—नियतावश्यकपूर्वभाविनः अवश्यकृतनियतपूर्ववर्तिन एव कार्यसम्भवे । तद्विज्ञम् (अतिरिक्तं) अवयवासिद्धं—Visvanátha, Siddhánta Muktváli, on Sloka 20. For example, it is the custom to point to spatial position or direction with the

fingers, but finger-pointing, though invariably present, is not causally related to the perception of direction or spatial position, because we can imagine such perception without finger-pointing, (अन्यथासिद्धतया बहुव्या निर्देशस्य दिक्प्रत्यक्षत्वेन न स्वाभाविकः सम्बन्धः, Vāchaspati, Tātparyya-Tikā, Chap, I, A'hnikā 1, Sutra 5,—this shows that the doctrine of अन्यथासिद्धिश्च was long anterior to Gangesa).

[Visvanātha in the Bhāsha-Parichchheda mentions five kinds of अन्यथासिद्ध, conditional antecedents—(1) येन सहपूर्वभावः (2) यस्य वा कारणमादाय (पूर्वभावः), (3) अन्यं प्रति पूर्वभावे ज्ञाते यत्पूर्वभावविज्ञानम्, (4) जनकं प्रति पूर्ववर्त्तिताम् अपरिज्ञाय यस्य (पूर्ववर्त्तिता) न गृह्यते, and (5) अथापि यत् नियतावश्यकपूर्वभाविनः अतिरिक्तम् भवेत् (एतेषु पञ्चषु आवश्यकस्वसौ—Slokas 19 and 20), यस्य स्वातन्त्र्येण अन्यव्यतिरेकौ न सः किन्तु स्वकारणमादायेव अन्यव्यतिरेकौ गृह्येते तदन्यथासिद्धम्, Siddhānta Muktaivali, loc. cit.—The Dinakarī points out that the first two cases are comprehended under the formula इतरान्यव्यतिरेकप्रयुक्तान्यव्यतिरेकशालितम्। There are several classifications of these irrelevant antecedents (अन्यथासिद्ध); I quote one of the best known].

The unconditional (अन्यथासिद्धिश्च) as interpreted in this comprehensive sense is a far more fruitful conception than Mill's, and is well adapted to its work—the elimination of the irrelevant factors in the situation. In the end, the discrimination of what is necessary to complete the sum of causes, from what

is dependent, collateral, secondary, superfluous or inert, (i. e. of the relevant from the irrelevant factors) must depend on the test of expenditure of energy. This test the Nyáya would accept only in the sense of an operation analysable into molar or molecular motion (परिचय एव भौतिको व्यापारः करोत्यर्थः—चतुर्द्वयस्य व्यापारो नास्ति, Jayanta, Manjarí, A'hnika I); but would emphatically reject, if it is advanced in support of the notion of a mysterious causal power or efficiency (शक्ति). This is a peculiarity of the Nyáya—its insisting that the effect is only the sum or resultant of the operations of the different casual conditions—that these operations are kinetic, being of the nature of motion, in other words holding firmly to the view that causation is a case of expenditure of energy, in the kinetic form,—but at the same time absolutely repudiating the Sāṅkhya conception of power or productive efficiency as metaphysical or transcendental (चतुर्द्वय), and finding nothing in the cause other than an unconditional invariable complement of operative conditions (कारकसामग्री) and nothing in the effect other than the consequent phenomenon which results from the joint operations of the antecedent conditions (समुद्दिष्टकालकारकनिर्धारः परिचय एव—Jayanta—सामग्री कार्ये—सामग्रीकार्यत्वे तु कार्यमस्य किमन्तराखर्वात्तया शक्त्या—Jayanta, *ibid*, A'hnika, 1, शक्तिनिराकरणम्—it may be noted that the Nyáya, while repudiating transcendental power (Sakti) in the mechanism of nature

and natural causation, does not deny the existence of metaphysical conditions like merit (*धर्मः*) which constitute a system of moral ends that fulfil themselves in and through the mechanical system and order of Nature—*vide* Jayanta. अतीन्द्रियं किमपि कारणं कल्पितमेव धर्मादि—A'hnika 1, शक्तिनिराकरणम्).

The causal relation, then, like the relation of genus to species, is a natural relation of concomitance (व्याप्तिः स्वाभाविकः सम्बन्धः—Vāchaspati) which can be ascertained only by the uniform and uninterrupted experience of agreement in presence and agreement in absence, and not by deduction from a certain *a priori* principle like that of Causality or Identity of Essence.

Nyāya objection to the Buddhist Method of Difference as a means of ascertaining causality.

Take for example the Buddhist deduction of Causality in any particular conjunction by means of the negative Method of Difference, or of the Panchakārani. The ascertainment of the causal relation by these Methods is open to the following objections :—(1) The unconditionality of the antecedent cannot possibly be ascertained. As the Chārvāka rightly points out, the Methods enable you to eliminate irrelevant antecedents that are or can be perceived ; but the introduction or sublation of latent or undetected antecedents can be imagined against which the Method of Difference is powerless. In the case of the production of

smoke, for example, by fire,—what if I say that an invisible demon intervenes in every case between the fire and the smoke, that this demon (दिमोच) is the immediate antecedent and real cause of the latter, and that the fire is an accident which, in every such case, is brought about by its own causal antecedents ;—in saying this, I do not go counter to the principle of causality and am landed in no contradiction (व्याघात) such as strikes at the very roots of all practice, or baffles the completed circuit of consciousness, however much I may violate probability.

(2) In the second place, even supposing that the fire, in this particular case (which satisfies the Method of Difference rigidly) is ascertained to be the cause of the smoke, how can I know that fire is the cause in other cases, or that there is no other cause. You will perhaps argue that if there were an *indefinite* number of causes of the same specific phenomenal effect, it would violate the principle that phenomena are all conditioned, *i.e.*, exist only under certain conditions (कादाचित्कत्व),—which is more comprehensive than the principle of causality, and the contradiction of which equally overthrows all rational practical activity. Yes, I accept the conditionality of phenomena, but this is not violated by supposing that one specific assemblage of phenomena has more than one cause. It is true that if you suppose such plurality of causes, you cannot establish the invariableness of

the particular conjunction (green-wood fire and smoke) which your Method of Difference fixes upon as a case of cause and effect ; in other words, with your special principle of Causality so restricted, and without any general principle of Uniformity of Nature to fall back upon, you cannot ascertain, from the present case, or from any number of similar cases that you may have observed, that *all* green-wood fires are followed by smoke ; *i.e.*, you are helpless in demonstrating with apodictic certainty (or ascertaining indubitably) the relation of cause and effect. But this is an objection against your own position, not mine. Why not admit at once that certain phenomena are naturally connected (as invariable concomitants or antecedents) with other phenomena, and take your stand on observed concomitance (uniform and uninterrupted experience of agreement in presence as well as absence) without assuming causality as an *a priori* principle and making deductions therefrom, and without the trouble of ascertaining the relation of cause and effect in every individual case. I am free to admit that theoretical objections of irresistible force (like those of the Chárváka Sceptics) can be urged against this ascertainment of universal invariable and unconditional concomitance (व्याप्तिवर्तमान्य) on the basis of mere observation. Doubts of this kind can no more be laid by my view of the matter than by your canons of causality and essential

identity (तदुत्पत्ति and तादात्म्य). Ultimately we all have to fall back on the rational practice of thinking persons (प्रेक्षावन्तः), and such persons are always content to act on practical certitude instead of hankering after an unattainable apodictic certainty in the affairs of life (प्रामाणिकसिद्धीकयामानुपासयता यथादर्शनं ब्रह्मनोयन्). This same practical certitude is also the ultimate warrant of the Deductive-Inductive Inference by which we ascertain the characters of things without direct perception and through the medium or instrumentality of a mark.

[To the earlier Buddhist canon of the Method of Subtraction, i. e., the negative Method of Difference, Uddyotakara and Vāchaspati of the Nyāya School pertinently and acutely object as follows :—

सत्यं यत् किञ्चित् कश्चित् दृष्टं तस्य यत् प्रतिबन्धः, तद्विदः तस्य तत् नमस्कं तत् इति अनुमानोक्तः । स एव तु प्रतिबन्धी न तावत् तदुत्पत्त्या सम्भवति । आ पुनरियं तदुत्पत्तिः । अमूल्यं किं वज्रानन्तरं भावः । स तादृशः अस्ति रासभस्यापि । तत्प्रतिबन्धीऽपि अमूल्यः स्यात् । अयं तदनन्तरमेव भावः, न च रासभानन्तरं भवन्नपि तदनन्तरमेव भवति, तस्मिन् सति अपि असति अग्री तदभावात् । असति अपि तस्मिन् सत्याद्वैश्वनवति वज्री तदभावात् । अथ यद्यपि अमूल्यं वज्रिभावानुविधानं तन्मोपलब्धं, तथापि दिशान्तरादिषु तदभावीऽस्य कुतश्चः । तथा हि भूयो भूयो रासमे दृष्टे अमूल्यो दृष्टः, तदभावे च अदृष्टः, न च तत्कार्यः । तज्जातीय-स्यैव अमूल्यं रासभं विना सति वज्री भावात्, एवं सत्यपि अग्री पिशाचेन जनिती अमूल्यः, कश्चिद्देशादौ तज्जातीय एव रासभवद्वज्रभावेऽपि पिशाचा-दिव भविष्यति, इति अवयव' ब्रह्मवा भाव्यं विज्ञानमन् अपश्यमान् । न च सति

भावभावं नियामकं, तस्य रासभादिषु अवशिष्टात् । तदनन्तरमेव इति च अवधारणस्य शङ्कायामभावात् । अवधारणेन तु शङ्कापनयने परस्परान्वय-प्रसङ्गात् ।

Buddhist reply :—स्यादेतत् । यो यो धूमो दृष्टः स सर्वथावत् आग्नेयनसङ्घितवज्रगन्तरमेव, न पिशाचान्तरं । स च कादाचित्कतया निमित्तमपेक्षमाणी यदनन्तरमेव गम्यते तदेव अप्रतीतव्यभिचारं निमित्तं करोति, न तु प्रतीतव्यभिचारं रासभादि । नापि सर्वथाऽनुपलब्धपिशाचादिः । यदि न तन्निमित्तं कदाचित् बिनाऽपि बद्धिं क्वचित् धूमो न उपलभ्यते । अथ असौ (पिशाचः) सर्वथा बद्धिसङ्घितः तथा सति आग्नेयनवत् कथं बद्धिरपि न कारणम् । कारणं चेत् कथं तमन्तरं धूमभावशङ्का । Now the phenomenon that is contingent (कादाचित्क) cannot be uncaused—अकारणस्य हि कार्यस्य नित्यं सत्त्वं असत्त्वं वा स्यात्, अनपेक्षत्वात् न कादाचित्कत्वम् । And with the limitation of a specific effect, there must be only one specific cause, for an unrestricted plurality of causes would amount to the denial of uniformity in causality (*i. e.*, of the *unconditional invariable antecedence*)—

नापि अनेकं कारणं, अकारणत्वप्रसङ्गादेव । वज्रगन्तरमेव भाव इति हि धूमस्य ब्रह्मकार्यत्वम् । स चेत् अवद्धेरपि अनन्तरं, न एवकारार्थः स्यात्, इति न बद्धेः कार्यम् । एवम् अन्यस्यापि न कार्यम् । न हि अन्यानन्तरमेव भवति, बद्धेरपि अनन्तरं भावात्, ततश्च अङ्गीतुको धूमः स्यात् । तद्या च कादाचित्कत्वव्यावृत्तिः ।

Nyāya rejoinder :—सत्यम् । यद्यपि बिना बद्धिं नोपलब्धो धूमः, यद्यपि च पिशाचान्तरं नोपलभ्यते तेषामनुपलब्धेः, तद्यपि पिशाच-

कार्यं एव धूमः । तच्च तत्र बद्धिः कुतश्चित् स्वहेतोः उपनिपतितः, रासभ इव,
न धूमस्य जनकः । तेन तदभावेऽपि तज्जातीय एव कारणमेदज्ज्या
कदाचित् कादाचित्की धूमः स्यात् । इति अनिश्चितीव शङ्कायाः ।
न च दृष्टसम्भवे नादृष्टं कल्पयितुं युक्तम् इति शक्यं भवार्थवक्तुम् । अनुप-
लब्धिलक्षणप्राप्तस्य अशक्यनिराकरणत्वात् (vide Nyāya Vindu) । न च
अनुपलब्ध्यन्तराणि अपि तन्निवेधे प्रभवन्ति । तस्यात् अनन्तरमेव इति
अवधारणाभावात् नैव कार्यकारणभावावधारणं युक्तम् । न च यदन्य-
सहितानन्तरं उपलब्धं तत्, तदन्यरहितात् तस्यात् भवत् भिन्नजातीयं भवति ।
उक्तं हि रामभसहितात् बद्धेः यादृशी धूमः तादृश एव तद्वरहितात् बद्धे-
रिति । तस्यादेर्बन्धा शङ्कापिशची स्वनिवारकं तदुत्पत्तिनिश्चयमास्कन्दती
न शक्या निवारयितुम् ।

The Nyāya proceeds to point out that what is contingent need not necessarily be produced by a cause. It is enough if there is natural connection with something else, a relation of antecedence and succession (or concomitance), without any element of productive efficiency or causation.

अपि चास्तु तदुत्पत्तिनिश्चयः तथाऽपि कस्यात् कारणमन्तरण न कार्यं
भवति । तथा च सति अनपेक्षतया कादाचित्कत्वविहितः इति चेत् ।
अस्तु तर्हि सम्बन्धः स्वाभाविकतया अन्यानपेक्षः अव्यभिचारि गमकत्वाद्गम् ।
स च यो वा स वा भवतु । कृतं कार्यकारणभावावधारणायासेन । यथा
चेतत् तथा चचे दर्शयिष्यामः । Vāchaspati, Tātparyya-Tikā,
Chāp. I, A'hnikā 1, Sutra 5, व्याप्तिवद्दीपायविचारः ।

The Nyāya analysis of the causal relation continued :—Co-effects :—In the enumeration of dif-

ferent varieties of irrelevant antecedents (अन्वयासिद्ध), we have already noticed that co-effects of the same Cause are apt to be confounded as cause and effect. In some cases, the co effects may be simultaneous, *e.g.*, the case of the ascending and the descending scale in a balance, which are co-effects of gravity (*vide* Pārtha-sārathi Misra on Kumārila, SlokaVārttika—तुलानमभीमनयोस्तु न मिथः कार्यकारणत्वम्, उभयोरेककारणत्वात्,—sloka 157, Sūnya-Vāda). In other cases, the co-effects may be successive effects of the same cause, and here the risk is great of mistaking the antecedent co effect to be the cause of the succeeding co-effect ; *e.g.*, the case of ants moving in a line to carry their eggs upward, which is observed before the summer rains ;—where the movement of ants and the rains are not cause and effect, but successive effects of the same cause, *viz.*, the heat (उष्ण), which disturbs the elements, *viz.*, the earth and the atmosphere (महाभूतक्षोभ) ; the ants being affected by this heat earlier than the atmospheric movements which bring the clouds and the rain.

(Uddyotakara, and Vāchaspati—न च पिपीलिकाश्च-
सचरणं वर्षस्य कारणमनुपलब्धसामर्थ्यात् । असत्यपि तस्मिन्
वर्षस्तीतपतेः । वर्षमूलकारणस्य तु महाभूतक्षोभस्य पिपीलिकाश्चसचरणं
पूर्वकार्यम् । कथ्यमानाः खलु पिपीलिका भूमिनीमणा खानि अण्डानि
भूमिहानि उपरिष्टात् नयन्ति—Tātparyya—Tikā II, 2, Sutra
37).

Synchronousness of Cause and Effect.—This is resolved into a case of simultaneous co-effects of the same ultimate cause, *e.g.*, the ascent of one scale and the descent of the other in the balance, which are not related as cause and effect, but are simultaneous effects of gravity. In other cases, the synchronousness is only apparent, the interval between the antecedent and the consequent being too small (सूक्ष्मकाल) to be apprehended (योगपद्याभिमान) *e.g.*, in the case of the needle piercing a hundred soft lotus petals laid one upon another, where the steps are really successive; or the illumination of the whole room by the light of a lamp, where the succession is unperceived owing to the inconceivable velocity of light (cf. Kumárilā, Sloka-Varttika,—हेतुहेतुमतां सिद्धं योगपद्यानिदर्शनम्.—यत् प्रदीपप्रभाद्युक्तं, सूक्ष्मकालोऽस्ति तत्र नः। दुर्लभसु यथा वेधः पद्मपत्रमते तथा। Sūnyavāda, Sloka 156-157.—I quote Mimāṃsā authorities, but the view is common to the Mimāṃsā and the Nyāya-Vaiśeṣika).

The time-relation in a chain of causes and effects :—A careful study of the time-relation in a chain of causes and effects is a peculiarity of the Vaiśeṣika system (and the later Nyāya). A moment (ultimate unit of time, Kṣana, क्षण) is defined to be the time-interval between the completion of the sum of conditions and the appearance of the effect. The Vaiśeṣika conceives the unit to be determined by reference to the division

of one atom from another (विभाजानुत्पाद्यविभाग प्रागभावसम्बन्धकार्यावच्छिन्नः कालः क्षणः—Sapta Padārthī, Sivāditya ;—*i.e.*, the ultimate unit of time is the time during which motion exists in an atom prior to its division from another atom, in a case of division due to motion). The Sāṅkhya, we have already seen, determines this ultimate unit by reference to the motion of a Tanmātra.

The number of such units will determine the time-interval between a given set of physical conditions and a particular effect, for between a so-called sum of causes and a so-called sum of effects, there intervenes a series of atomic (or molecular) motions, with conjunctions and disjunctions which form the causal chain. However crude in the practical application, the fundamental idea is, in connection with the principle of work and energy (for which both the Sāṅkhya and the Nyāya-Vaiśeṣika furnish a rudimentary basis), immensely suggestive of a possible Time Calculus.

Plurality of Causes :—This will be discussed, when we consider the relation of Vyāpti to the principle of Causality.

The Nyāya Ground of Inference—Vyāpti नियत-साहचर्य—Vāchaspati):—Inference, then in the Nyāya, depends on the ascertainment, not of the casual relation, nor of the relation of genus to species, but of a natural relation, between two phenomena, of invariable and unconditional concomitance

(उद्योतकिः स्वाभाविकः सम्बन्धः अस्ति:—Uddiyotakara and Váchaspati). Of the two phenomena so connected, one is called the Vyápya or Gamaka (the sign, mark or indicator), and the other Vyápaka or Gamyá (the thing signified, marked, or indicated). In the relation of fire and smoke, for example, smoke is the Vyápya or Gamaka (sign or mark); and fire, the Vyápaka or Gamyá the thing signified or marked). Now the relation of Vyápti between *A* and *B* may be either unequal or equipollent (विषमव्याप्ति or समव्याप्ति). When *A* is the sign of *B*, but *B* is not the sign of *A*, the Vyápti is one-sided or unequal, and here a Vyápti is said to exist between *A* and *B*, but not between *B* and *A*. For example, smoke is a sign of fire, but fire is not universally a sign of smoke. When, therefore, the relation of Vyápti is an unequal one, as between smoke and fire, it is expressed in the proposition :—Wherever the Vyápya (sign or mark, *e.g.*, smoke) exists, the Vyápaka (the thing signified or marked, *e.g.*, fire) also exists. From this it follows by necessary implication (a sort of चर्यापत्ति) that whenever the Vyápaka (*e.g.*, fire) is absent, the Vyápya (*e.g.*, smoke) is also absent (व्यापकाभावे व्याप्याभावः). Again the Vyápti may be a mutual or equipollent one, *i.e.* *A* and *B* may be signs of each other, *e.g.* green-wood fire and smoke. Here each in turn is Vyápya and Vyápaka, and this is expressed in

the two propositions :—(1) Wherever there is smoke, there is green-wood fire, and (2) wherever there is green-wood fire, there is smoke. By necessary implication it follows—(1) where there is no green-wood fire, there is no smoke : (2) where there is no smoke, there is no green-wood fire. We have seen that a Vyápti exists between smoke and fire, for wherever there is smoke, there is fire. But we cannot say that a Vyápti exists between fire and smoke, for we cannot say that wherever there is a fire, there is smoke. The combustion of an iron-ball (अग्नीमल्लक) for example, is a case of fire without smoke. But it would be correct to say that a Vyápti exists between green wood fire and smoke, as well as between smoke and green-wood fire. The question, therefore, is—What is the relation between fire and smoke ? The relation between fire and smoke is a conditional relation ; i.e., on condition that the fire is green-wood fire, it would be a sign of smoke. In other words, a Vyápti implies unconditional invariable concomitance, and the relation between fire and smoke is not therefore a Vyapti (natural unconditional concomitance), for fire requires a ‘condition,’ Upádhi. *viz.*, green-wood, to be followed by smoke. Smoke, on the other hand, requires no ‘condition’ to indicate fire. For the purposes of Inference, therefore, relations between phenomena may

be considered as of two kinds :—(1) Contingent conditional relations, holding good on the fulfilment of a certain condition or Upádhi, and (2) Vyápti, or unconditional invariable relation, between a mark and that which it makes, a relation without any Upádhi or determining condition (उपाधिविधुरः सम्बन्धः). It is this latter kind of relation that serves as the ground of Inference. If we can ascertain that a Vyápti exists between *A* and *B*, then *A* is a sign of *B*, and an inference of the presence of *B* from the presence of *A*, and of the absence of *A* from the absence of *B*, would be warranted. The question, therefore, is—how to ascertain the relation of Vyápti between two phenomena.

Ascertainment of Vyápti according to the early Nyáya (आदिग्रहीपाय).—Briefly speaking, the observation of agreement in presence (सम्बन्ध) as well as agreement in absence (व्यतिरेक), between two phenomena, with the non-observation of the contrary (व्यभिचारदर्शनम्). is the foundation of our knowledge of Vyápti (दर्शनदर्शने—Váchaspati). This suggests a natural relation (स्वाभाविकसम्बन्ध—Váchaspati) of invariable concomitance (नियतसादृश्यम्—Váchaspati) between the phenomena, which is fortified by our non-observation (अदर्शन) of the contrary (व्यभिचार). But this does not establish the unconditionality of the concomitance (उपाधिविधुरसम्बन्ध), which is essential to a Vyápti. We have therefore to examine the cases carefully

to see if there is any determining condition (Upādhi—i. e. some hidden or undetected but really operative or indispensable accompaniment) which conditions the relation between the supposed sign or mark (Gamaka) and the supposed signate (thing signified, Gymya). Now let us consider what constitutes an Upādhi. It is a circumstance which always accompanies, and is always accompanied by, the supposed signate (the thing signified, Gamyā), but does not invariably accompany the supposed sign or mark (Gamaka). If, therefore, in the set of positive instances where both the sign and the signate are present, nothing else is constantly present, there can be no Upādhi. Or, again, if in the set of negative instances where both the sign and the signate are absent, no other material circumstance is constantly absent, there is no Upādhi. This follows from the very definition of an Upādhi. It is impracticable to fulfil these requirements rigorously. Still, every one of the accompanying circumstances (of course the likely ones) may be taken successively, and it may be shown that the concomitance continues even when the suspected Upādhi (अतिव्याप्ति) is absent, and therefore it cannot be the Upādhi. And this is to be fortified by the observance of uniform and uninterrupted agreement in absence (Vyatireka) between the two concomitant phenomena. In this way, when we have disproved all

suspected Upádhis, we conclude by establishing the Vyápti. It is true that we may still go on doubting. But doubt has a certain limit for the 'experimenter' and the thinking person (परीक्षक, प्रेक्षकान्). When doubt overthrows the foundation of all rational practice (मानाधिकलीक्याना), or leads to a stoppage or arrest of all practical activity (लीक्यवहार), it stands *ipso facto* condemned, and must be abandoned (व्याघातादधिरागहा), Śrīharsha and Udayana—व्याघात is mentioned by Vāchaspati). Thus it is that Vyápti is ascertained. In this way, we observe innumerable instances of Vyápti. Now by means of repeated observations of this kind (भूयोदर्शन), we have established the principle of the Uniformity of Nature (स्वभाव-प्रतिबन्ध), and also of Causality; and these two principles thus ascertained may be made use of in their turn as the basis of an argumentation or deduction (Tarka, U'ha, तर्क) to confirm a particular Vyápti in a particular case. Tarka or U'ha, then, is the verification and vindication of particular inductions by the application of the general principles of Uniformity of Nature and of Causality, principles which are themselves based on repeated observation (भूयोदर्शन) and the ascertainment of innumerable particular inductions of uniformity or causality (भूयोदर्शनजनितसंस्कारसहितम् इन्द्रियमेव स्वामाधिकसम्बन्धवादि—Vāchaspati). Thus Tarka also helps in dispelling doubt (वन्देह). Śrīharsha,

however, questions the validity of this verification, —cf. the well-known couplet ending तर्कः शङ्कावधिः कुतः ।

It will be seen that the process of disproving all suspected Upádhis (उपाधिशङ्कानिरास), in the early Nyáya, answers exactly *as a process* to Mill's Method of Agreement. In fact, the disproof of a suspected Upádhi by pointing to instances of Agreement in absence (अन्वय) even in the absence of the Upádhi, fortified as this is by the instances of agreement in absence (व्यतिरेक), virtually amounts to Mill's Joint Method of Agreement. But the fundamental difference is this :— Mill's Method of Agreement is formulated in view of the phenomena of causation (including co-effects, etc.) and, as usually enunciated, confessedly breaks down in dealing with cases of Uniformities of Co-existence unconnected with Causation; the Nyáya Method based on the disproof of suspected Upádhis is a more daring and original attempt, and is far more comprehensive in scope, being applicable to all Uniformities of Co-existence and of Causation alike. And this the Nyáya successfully accomplished, by introducing the mark of unconditionality (उपाधिविधुरता) into the relation of Vyápti (Concomitance), even as the same mark of unconditionality (अन्वयाविवक्षितता) had been previously introduced into the definition of Causality (कार्यकारणभाव). The difference between the early Nyáya and the Buddhist systems

may be briefly put thus :—The former relied on empirical induction based on uniform and uninterrupted agreement in Nature, and accordingly regarded the Method of Agreement as the fundamental Method of Scientific Induction, founding Inference on Vyápti to which they subordinated Causality in the doctrine of Method ; the latter assumed two *a priori* principles, viz., causality and identity of essence, deduced the canon of the Method of Difference by an indirect proof from the principle of causality, and made this Method the foundation of all scientific Induction of Causality, just as they based all natural classification of Genera and Species on their *a priori* principle of Identity of Essence.

[Text from the early Nyáya :—

Method of Agreement and the Joint Method without the device of the Upádhi :—

Cf. Jayanta on साङ्ख्यिक्यं—तस्मिन् सत्येव भवने न विना भवनं ततः । अथमेवाविनाभावो नियमः सङ्गचारिता । ‘तस्मिन् सत्येव’ ‘only this remaining throughout,’ while others change—implying the Method of Agreement. The set of positive instances, in which this antecedent alone is constant, must be supplemented by a set of negative instances (agreement in absence) :—व्यतिरेकनियमननरीष प्रतिबन्धसङ्गच्छानुपपत्तेः । नियमसाधं उच्यते यत् तस्मिन् सति भवनं ततो विना न भवनं इति सूचीदर्शनम् । तत्र तस्मिन् सति भवनं इत्यन्वयमात्र-

परिच्छेदात् अर्हं गृहीतो नियमः स्यात् । ततो विना न भवन् इत्यस्य
अर्थक्यं अपरिच्छेदात् इति Jayanta, A'hnika II, व्यतिरेकव्याप्ति-
नियथावश्यकत्वम् ।

Doctrine of the Upādhi :—Unconditional con-
comitance distinguished from conditional :—

यो वा स वा असु सम्बन्धः यस्य असौ स्वाभाविको नियतः स एव गमकः,
गम्यश्च इतरः सम्बन्धीति युज्यते । तथा हि धूमादीनां बह्नादिसम्बन्धः
स्वाभाविकः । नतु बह्नादीनां धूमादिभिः । उपलभ्यन्ते ते हि विनापि
धूमादिभिः । यदातु आर्द्रेन्वनादिसम्बन्धम् अनुभवन्ति तदा धूमादिभिः सह
संबध्यन्ते । तस्मात् बह्नादीनाम् आर्द्रेन्वनाद्युपाधिकृतः सम्बन्धो न स्वाभा-
विकः । ततो न नियतः । स्वाभाविकस्तु धूमादीनां बह्नादिसम्बन्ध उपधिः
अनुपलभ्यमानात् क्वचित् व्यभिचारस्य अदर्शनात् अनुपलभ्यमानस्यापि
कल्पनानुपपत्तेः । अतो नियतः सम्बन्धः अनुमानाङ्गम् ।

Concomitance sufficient without causal *nex-
us* :—

The Buddhist objects—In Nature, everything is
connected with everything else. Hence if there
were no *nexus* of causality between antecedent
and consequent, everything might follow from
everything else. The Nyāya replies—You admit
uniformities (of co-existence, etc.) other than
causal ;—so you confess that a natural fixed order
can exist without causal *nexus*.....

An Upādhi, how established and how dis-
proved :—

The Nyāya then proceeds to show how an Upādhi

is established, or how disproved by observation.—
तत्र ब्रूते: अनार्हेत्यनस्य विना धूमम् अधोगोलकादौ दर्शनात् आर्हेत्यनो-
पाधिः अस्य धूमेन सम्बन्धः न तु स्वाभाविक इति नियीयते । धूमविशेषस्य
तु विना बहिर्धूमं अनुपलब्धात्, उपाधिभेदस्य च अदृश्यमानस्य कल्पनायां
प्रमाणाभावात्, विशेषकृत्यपेक्षस्य च संशयस्य अनुपलब्धपूर्वम् अनुत्-
पादात्, उत्पादे च अतिप्रसङ्गात् प्रेक्षावत् प्रहृत्यच्छेदात्, स्वाभाविकः
सम्बन्धः अवधार्यते ।

General Method of Induction by exhaustion
of the Upādhi, more comprehensive than Mill's
Joint Method :—

For the definition of an Upādhi, vide Srīharsha and
Udayana : अव्याप्तसाधनो यः साध्यसमव्याप्तिः उच्यते स उपाधिरिति ।
Hence to avoid an Upādhi (which is साध्यसमव्याप्तिः),
the constant presence of anything relevant other
than the sign and the signate in the positive ins-
tances (of agreement in presence, अन्वय), and the
constant absence of any such thing in the negative
instances (of agreement in absence, व्यतिरेक) must
be safe-guarded against. This amounts to Mill's
Joint Method.

Suspicion of non-perceptible Upādhi—Limits of
legitimate Doubt :—

न च अदृश्यमानोऽपि दर्शनानर्हत्तया साधकवाधकप्रमाणाभावेन
संदिग्धमान उपाधिः स्वाभाविकत्वं प्रतिवध्नाति इति साम्प्रतम् । अथर्व-
श्रुत्या भवितव्यं नियामकाभावादिति दत्तावकाशा खलु इयम्
प्रमाणाभ्यादातिक्रमेण श्रद्धा पिशाची जम्भप्रसरा न कश्चित् नास्तीति ज्ञेयं

कचित् प्रवर्तेत। सर्व्वमेव कस्यचित् कस्यचित् अनर्थस्य शङ्कास्यदत्तात्। अनर्थशङ्कायाश्च प्रेक्षावर्ता निवृत्त्यकृतात्। अन्ततः सिद्धान्तपानोपयोगेषु अपि सरणादिदर्शनात्। तस्मात् प्रामाणिकलीकयावाम् अनुपालयता यथादर्शनं शङ्कनीयम्।.....तस्मादुपाधिं प्रयत्नेन अन्विष्यन्तोऽनुपलभमाना नास्तीति अवगम्य स्वाभाविकत्वं सत्यत्वस्य निश्चिनुमः।—

Tarka, U'ha,—Deductive verification of particular inductions by applying the two fundamental inductions of Uniformity of Nature, and Causality :—Doubt finally dispelled :—

Now innumerable particular uniformities of this kind (Vyáptis) are observed, and as a result of this repeated observation, a belief in the Uniformity of Nature (स्वाभावप्रतिबन्ध), as well as in the principle of Causality (कार्यकारणभाव) is generated in the mind, a belief which has evidential value and validity. It is not intuition (न मानसम्) but a mental pre-disposition based on uniform and uninterrupted experience (भूयोदर्शनजनितसंस्कारसङ्घितम् इन्द्रियमेव स्वाभाविकसत्यत्वस्यादि,—अत्र भूयोदर्शनम् असाम्प्रसारणम् इति प्रमाणात्मानं जातम्). Then armed with these new resources, the belief in uniformity and in causality as general principles, we proceed to fortify our particular inductions (Vyáptis), whether of uniformity of nature or of causality, by indirect deduction from these general principles :—We argue if, under these observed circumstances, *A* were not the mark of *B*, the principle of uniformity of nature would be violated,—Nature would not be uni-

form.—or, if under these observed circumstances *A* were not the cause of *B*, the principle of causality would be violated, the phenomenon *B* would be without a cause ;—and such indirect proof (तर्क, ऊह) gives us the overwhelming probability which we call practical certitude, and on which every reasonable man (every thinking and judging person) proceeds to act in due natural course.—
 स्वभावतश्च प्रतिबद्धा इति चेत् स्वसाध्येन, यदि साध्यजनकरी च भवेद्युः, स्वभावादेव प्रत्यवेरन्निति तर्कसहायः अनिरस्तसाध्यव्यतिरेकवृत्तिसंदिग्हा यत्र दृष्टाः, तत्र स्वसाध्यम् उपस्थापयन्त्येव । Vāchaspati I, 1, Sutra 5 ; cf. also, I, 1, Sutra 40—ऊहः कारणास्तीपपक्षा संभवेन ज्ञायते । कारणासम्भवे कार्यस्य असत्त्वात् ।]

Instances of Vyāpti (uniformity) not comprehended under Causality, or the relation of Genus and Species :—The Nyāya points out that the relations of cause and effect and of genus and species do not exhaust the grounds of Inference. There are cases of Inference based on Vyāpti (i. e., on invariable and unconditional concomitance) which come neither under Causality (तदुत्पत्ति) nor under Identity of Essence, (तादात्म्य). Vāchaspati notes that to-day's sunrise and yesterday's sunrise, the rise of the moon and the tide in the ocean, the relative positions of the steller constellations, are instances of Vyāpti (invariable concomitance) between phenomena which are neither related as cause and effect, nor as genus and species. Jayanta adds the conjunction of sun-set with the appearance of the stars,

of ants moving in procession (with their eggs) with the approach of the rains,—of the rising of the constellation Agastya (Canopus) above the horizon with the drying up of rivers ; of the spring tide with the full moon ; and dismisses as sophistical and far-fetched the Buddhist attempt to explain all these cases by means of causality. We have seen that the Nyáya and the Mimánsá reduce most of these conjunctions to cases of co-effects of the same cause, co-effects which may be either simultaneous or successive.

अपि च अद्यतनस्य सवितुदयस्य ज्ञानेन सवितुदयेन, चन्द्रोदयस्य च समानकालेन समुद्रवृद्ध्या.....न कार्यकारणभावः तादात्म्यं वा । अथ च दृष्टो व्यगमकभावः ।—Váchaspati, Tátparyya-tíká, I, 1, Súra 4 ;—Cf. also Jayanta, Nyáya Manjarí—अथैवानपि ईर्त्तुर्ना भूत्वा जनति दर्शनात् । सूर्यास्तमयमासीक्य कल्पते तारकीदयः । पूर्णचन्द्रोदयाद्दृष्टिरणुधेरवगम्यते । सदितेनानुमीयन्ते वरितः कुम्भयोगिनः । युध्यत्पुलिनपर्यन्तं विश्रान्तखनपक्षयः । पिपीलिकाश्चसञ्चारचेष्टानुमितवृष्टयः । भवन्ति पक्षिकाः पर्यङ्कुटीरकरणोद्यताः ।

Vyápti between Cause and Effect :—Relation of causality to Vyápti :—

On the Buddhist (and early Nyáya) view that one specific assemblage of 'effect' phenomena has one specific assemblage of causal conditions, there would be two aggregates, the sum of causal conditions (कारणसमष्टौ), and the sum of effects (कार्य-समष्टौ). For example, fire requires green-wood to complete the sum of causal conditions to give rise to smoke with some particular marks (चूर्णविशेषः—

वहुलपास्तुतादिष्वर्थविशिष्ट, Jayanta II ; compare Gangesa कृष्णागुदप्रभववद्विमानयं कटुकासुरभिपास्तरश्च नवत्वात् ।—Chintāmani, Anumana, Viruddha Siddhānta). Here, between an effect and a single condition (termed a cause) there is a relation of Vyāpti. The effect is Vyāpya or Gamaka (the sign or mark) ; the cause (or condition) is Vyāpaka or Gamyā (the thing signified). In other words the presence of the effect indicates the presence of the causal condition, and the absence of the causal condition will by implication indicate the absence of the effect. Smoke of this particular kind is supposed to be an effect of which there is one and only one assemblage of causal conditions (fire and green-wood) ; hence where there is smoke, there is fire ; and when there is no fire, there is no smoke.

Now introduce the complication of the plurality of causes :—Fire, for example, is the effect of several assemblages, *e. g.* (1) blowing on heated grass, (2) focussing rays through a lens on a combustible like paper or straw, (3) friction with the fire drill, etc. Here each assemblage is regarded as a sum of causes. But in this case there is no Vyāpti between the effect 'fire' and any particular assemblage of causal conditions, say, of the lens or the fire drill. For the presence of fire does not indicate the presence of the lens or the fire drill, assemblage, nor does the absence of either of the latter in particular, indicate the absence of fire.

Indeed in such a case, the effect 'fire' is not a mark or sign (Gamaka or Vyápya) of any one in particular of the different possible causal assemblages, though each of these particular assemblages of causal conditions is a mark or sign (Gamaka or Vyápya) of fire.

The plurality of causes requires a further consideration in the light of the definition of the causal relation. A cause is defined to be the unconditional invariable antecedent. From the unconditionality, it follows that the entire sum of conditions, and not one single condition, is, properly speaking, the cause. In view of the plurality of causes, an invariable antecedent must be taken to mean that any particular cause (i. e., assemblage of causal conditions) is invariably followed by the effect,—not that the effect is invariably preceded by any particular cause.

Popularly, a single condition, say the lens or the fire-drill, is said to be a cause of fire ; but, in view of the plurality of causes, this is apt to be misleading, as there is no Vyápti in this case : the lens or the fire-drill is no more a mark of fire than fire is a mark of the lens or the fire-drill.

The plurality of causes strains the definition of a cause, and undermines the relation of Vyápti between an effect and a cause. Any particular cause (causal aggregate) still indicates the effect, but not *vice versa*. The earlier Nyáya (down to

Váchaspati and Jayanta) obviated the plurality, as we have seen, by introducing distinctive marks in the effect such as would indicate a single specific cause (काव्य'वैश्वस्य or काव्य'निद indicating कारणवैश्वस्य or कारणनिद). Some indeed went further and held that when the antecedent causal assemblages differ in kind, the effect phenomena, though apparently the same, do really differ specifically (or in kind)—कारणवैजात्यान् काव्य'वैजात्यम् । But the Nyáya discards this hypothesis ; the fire is the same, though the possible causes (or causal aggregates) differ, *e. g.*, the lens, the drill, etc. But the effect phenomenon to which we attend is not the only effect ;—in the case of plurality of causes, we must carefully examine the accompaniments of the effect, *i. e.*, the sum of effects, and the examination will shew some distinctive or specific circumstance or accompaniment which will enable us to definitely determine the particular assemblage of causal conditions that must have preceded in the case under examination. This is the device of the earlier Nyáya as well as of the Buddhists, as we have seen ; but the later Nyáya doubts the practicability as well as the theoretical validity of such a step on an unrestricted assumption of the plurality of causes, and feels troubled by the circumstance that no effect for which more than one cause (or causal aggregate) can be assigned, can be regarded as a mark or sign (Gamaka or Vyápya) of any one of

the causes in particular. Accordingly, some adherents of the later Nyāya advanced the proposition that when more than one causal aggregate can be supposed for any effect, the latter is a mark or sign (*Gamaka* or *Vyāpya*), not of any one of the causal aggregates in particular, but of one or other of them ; and the absence, not of one such cause, but of each and every one of them, alone indicates the absence of the effect. A cause therefore should be defined to mean *one or other* of the possible alternative aggregates which, being given, the effect follows invariably and unconditionally. If we ask what is the defining mark (or quiddity) of the cause (*कारवतापक्षेदक*), we are told that it is *one-or-otherness* (*एकवचनत्व*), and nothing else ; others cut the Gordian knot by assuming that the different possible causes of the same effect possess a common power or efficiency (*अतिरिक्तशक्ति*), or a common 'form' (*जातिसौम्य*), which accounts for the production of a common effect. The latter is therefore a sign or mark of this power (*शक्ति*), or this form (*जातिसौम्य*), which is manifested by each of the causal aggregates. This hypothesis (*कल्पना*), they hold, is simpler and more plausible than the hypothesis of specific differences latent in the apparently identical effect of a plurality of causes (*कारववेजात्वात् कार्यवेजात्वात्*).

(Cf. *Dinakarī* on the *Siddhanta Muktaavali*—*केचित्तु*

अङ्गि' प्रति दृष्टव्यत्कार-संयोगादीनां दृष्टव्यत्कारसंयोगत्वादित्येव

कारणतया व्यभिचारीय असम्भवात् अतिरिक्तशक्तिसिद्धिः । न च
 दृष्टफुत्कारयोः अरविनिर्मलेयाः सन्धितरविप्रकाशयोश्च सम्बन्धस्य
 जन्वतावच्छेदकं वज्रहतिवैजात्यत्रयं कल्पामिति न व्यभिचार इति वाच्यम् ।
 तज्जन्वतावच्छेदकवैजात्यत्रयकल्पनामपेक्ष्य तत्तत्सम्बन्धानां एकशक्तिमत्त्वेन
 कारणत्वकल्पनाया एव लघुत्वेन व्याख्याता इत्याहुः । तत्र ।... अन्यतमत्वेन
 कारणतासम्भवात्..... परे तु दृष्टादिरुन्मत्तकाखीनवायुसंयोगादीनां एक-
 शक्तिमत्त्वेन हेतुतामादाय विनिगमनाविरहात् न शक्तिसिद्धिः इत्याहुः ।
 Sloka 2, cf. also, दृष्टारविमन्वन्तमलं कारणस्य विनिगमकम् ।

Cf. Udayana, Kusumánjali, Stavaka 1— कर्तृर्हि
 दृष्टारविमन्विभ्यो भवन्नाद्यद्युच्चरितकजातीयः । एकशक्तिमत्त्वात्-
 इति चेत् न । यदि हि विजातीयेषु अपि एकजातीयकार्यकारण-शक्तिः
 समवेयात्, न कार्य्यात् कारणविशेषः कश्चित् अनुमीयत । कारणव्याख्या च
 न तज्जातीयस्यैव कार्य्यस्य व्याख्यास्वरूपीयत ।..... एतेन सूत्रजातीयमिति
 निरस्तम् । अवज्ञेरपि तत्सौख्यात् समीतपक्ष्यापत्तेः ।

The Scientific Methods already noticed, the Joint Method of Difference (the Panchakārāni), and the Joint Method of Agreement (Vyāptigraha with Upādhisankā-nirāsa and Tarka), are not the only methods of ascertaining causality or concomitance, or establishing a theory (सिद्धान्त); nor are these Methods always practicable. Very often, we reach the explanation of a fact (उपपत्ति) by means of a Hypothesis (कल्पना) properly tested and verified (निर्णयः). A legitimate Hypothesis must satisfy the following condition :—(1) the hypothesis must explain the facts (दृष्टसिद्धि, or उपपत्ति ; (2) the

hypothesis must not be in conflict with any observed facts or established generalisations (दृष्टसिद्धये हि षट्ठं कल्पाने, न दृष्टविधाय—Jayanta, Nyāya-Manjari, A'hnika 1); (3) no unobserved agent must be assumed, where it is possible to explain the facts satisfactorily by observed agencies (यदि षट्ठमन्तरेण दृष्टं न सिद्धाति काममदृष्टं कल्पताम्, अन्यथाऽपि तदुपपत्तौ किं तदुपकल्पनेन, *ibid*); (4) when two rival hypotheses are in the field, a crucial fact or test (विनिगमक, *ratio sufficiens*) is necessary; the absence of such a test (विनिगमनाविरह) is fatal to the establishment of either, (5) of two rival hypotheses, the simpler, *i.e.*, that which assumes less, is to be preferred (*ceteris paribus*) (कल्पनालघव *versus* कल्पनागौरव); (6) of two rival hypotheses, that which is immediate or relevant to the subject-matter is to be preferred to that which is alien or remote (प्रथमोपस्थितत्व); (7) a hypothesis that satisfies the above conditions must be capable of *verification* (निर्णय) before it can be established as a theory (सिद्धान्त). The process of verification of a hypothesis consists in showing that it can be deduced as a corollary from (or is involved by implication in some more general proposition which is already well-established (cf. Vatsyayana's exposition and illustration of Verification, निर्णय—including both the Deductive Method and Colligation).

This doctrine of Scientific Method, in Hindu Logic, is only a subsidiary discipline, being com-

prehended under the wider conception of Methodology, which aims at the ascertainment of Truth whether scientific (Vijnana) or philosophical (Jnana) (नीचे धीर्ज्ञानं स्यात् विज्ञानं त्रिविधाऽस्तीः, Amara-Kosha);—the latter being the ulterior aim. In the investigation of any subject, Hindu Methodology adopts the following procedure : (1) the proposition (or enumeration) of the subject-matter (Uddesa), (2) the ascertainment of the essential characters or marks, by Perception, Inference, the Inductive Methods, etc.,—resulting in definitions (by लक्षण) or descriptions (by उपलक्षण); and (3) Examination and Verification (परीक्षा and निश्चय). Ordinarily the first step, Uddesa, is held to include not mere Enumeration of topics, but Classification or Division proper (विभागः उद्देश्यरूपानुपायानु उद्देश्य एवास्ती । सामान्यसंज्ञया कीर्तनमुद्देशः प्रकारनिर्देशंज्ञया कीर्तनं विभाग इति—Jayanta, Manjari); but a few recognise the latter as a separate procedure coming after Definition or Description. Any truth established by this three-fold (or four-fold) procedure is called a Siddhānta (an established theory). Now the various Pramānas Proofs, *i e.*, sources of valid knowledge) in Hindu Logic. *viz.*, Perception, Inference, Testimony, Mathematical Reasoning (लक्षण including Probability in one view) are only operations subsidiary to the ascertainment of Truth (तत्त्वनिश्चय). And the Scientific Methods are merely ancillary to these Pramānas themselves.

I have explained the principles of the Hindu doctrine of Scientific Method, avoiding the technicalities of Logic as far as possible ; and I cannot here enter upon the logical terminology or the logical apparatus and machinery, which would require a separate volume to themselves. For these, I would refer the reader to my paper on Hindu Logic,—as also for an account of the later Nyāya (न्याय), which, in spite of its arid dialectics, possesses a three-fold significance in the history of thought : (1) logical, in its conceptions of Avachchhedaka and Pratiyogi, being an attempt to introduce quantification on a connotative basis, in other words, to introduce quantitative notions of Universal and Particular, in both an affirmative and a negative aspect, into the Hindu theory of Inference and Proposition regarded connotatively as the establishment of relation among attributes or marks ; (2) scientific, in its investigation of the varieties of Vyāpti and Upādhi, (and of अवधारित्व) being an elaboration of Scientific Method, in the attempt to eliminate the irrelevant ; and (3) ontological and epistemological, in its classification and precise determinations of the various relations of Knowledge and Being, with even greater rigidity and minuteness than in Hegel's Logic of Being and Essence. I will conclude with a few observations on Applied Logic, i.e., the logic of the special sciences, which is such a

characteristic feature of Hindu scientific investigation. What is characteristic of the Hindu scientific mind is that without being content with the general concepts of Science and a general Methodology, it elaborated the fundamental categories and concepts of such of the special sciences as it cultivated with assiduity, and systematically adapted the general principles of Scientific Method to the requirements of the subject-matter in each case. The most signal example of applied logic (or Scientific Method) worked out with systematic carefulness is the Logic of Therapeutics in Charaka, a Logic which adapts the general concepts of cause, effect, energy, operation, etc., and the general methodology of science, to the special problems presented in the study of disease, their causes, symptoms and remedies (*vide* Charaka, *Vimánasthána*, Chap IV,—also *Sutra Sthána*, —*vide* my Paper on Hindu Logic). Here I will give an illustration of Applied Methodology from the Science of Analytical and Descriptive Grammar. Patanjali, in the *Mahá-bhášya*, (*Circa* 150 B. C.) is very careful as regards Methodology. I take no note now of the philosophical presuppositions of his philology (*vide* my Paper on the Hindu Science of Language), but will confine myself to his presentation of the Applied Logic of Descriptive and Analytical Grammar. The sentence is the unit of speech, as every Hindu philologist contends, but the first business of Analytica

Grammar is to analyse the sentence into its significant parts and their coherent relations to one another. Assuming that articulate sounds are significant, the question is.—how is the sentence, which is the unit of articulate speech, broken up into significant words and their mutual relations? Pātanjali answers that this is done by an instinctive use (cf. Vāchaspati's भूयो दर्शनजनितसंस्कारम् इन्द्रियम्) of the Joint Method of Difference (combined Addition and Subtraction), fortified by the Joint Method of Agreement (चन्वय-व्यतिरेकौ). Pātanjali starts with a simple case. Take the two sentence-units :—Pathati (he reads) and Pachati (he cooks'. Suppose you start with the assumption that these sounds are significant, and *that separate elements have separate meanings*. Then you hear Pathati, and, at the same time, a man reading is pointed at. Then the assemblage of sounds Pathati (i. e., Path+ati) stands for the assemblage—'one reads,' (i. e. the action reading+an individual agent). Similarly by finger-pointing or other indication, you find that the assemblage Pachati i. e., Pach+ati) stands for the assemblage 'one cook's (i. e. the action cooking +an individual agent, say, the same agent as before).

Now look at the grouping :—

Path + ati = reading + one agent.

Pach + ati = cooking + one agent.

From repeated observation of similar groupings, one is led to conclude that path is the invariable concomitant of the action 'reading', because the disappearance of the former (the other element remaining) leads to the disappearance of the latter (a rough Method of Difference by subtraction—होयते); that Pach is the invariable concomitant of the action 'cooking' because the introduction of Pach (with nothing else added) leads to the introduction of the action 'cooking,' (a rough Method of Difference by addition,—उपजायते); and that Ati, which is the only 'common antecedent' (अन्वयी). is the invariable concomitant of 'one agent' which is the only common 'consequent' (अन्वयी). In fact, the last should come first by the Method of Agreement, then the other two either by Residue, or by Joint Agreement in presence and absence (अन्यव्यतिरेकी). So far all is plain sailing, though only very simple and very rough applications of the Methods are given. But—and this is the point—throughout the argument, it is assumed that one sound is the concomitant of one idea, in other words, there is no plurality of causes to vitiate the application of the Method of Agreement in the above example. And now the objection is advanced that this basal assumption is untrue. The same sound is not the concomitant of the same idea. Different words (sounds) may have the same meaning, and the same word (sound) may have

different meanings. We cannot therefore by the Joint Method of Agreement (अन्वयव्यतिरेकी) determine the meanings of words, or the separate functions of roots (stems) and inflections,—at least not so simply as is pretended above. Patanjali states this difficulty in the way of applying the Scientific Methods to the problems presented by Analytical Grammar, a difficulty arising from the plurality of causes, but does not state the solution. The solution, however, depends on the Method of subtraction and addition (Patanjali's होयते and उपजायते). For it will be found by extensive observation that the number of meanings of which a word (sound) may be capable is limited. So also is the number of words (sounds) expressive of a given meaning. Hence, by the Method of Difference, etc., the causal relations of words and meanings may be determined. Patanjali thus established the doctrine of Prakriti and Pratyaya (roots and inflections), with their separate significance, which is of course a necessary postulate in the case of an inflectional language like Sanskrit. Isolating and Agglutinative languages offer less difficulty whereas the difficulties are in some respect enhanced in the case of languages with a polysynthetic or incorporating (incapsulating) morphological structure.

कथं पुनर्ज्ञायते अयं प्रकृत्यर्थः अयं प्रत्ययार्थ इति । अन्वयव्यतिरेकी नाम :
कोऽसौ अन्वयो व्यतिरेकी वा । इह पञ्चोक्तौ कश्चित् शब्दः श्रूयते ।

पठतीत्युक्ते कश्चित् शब्दो होयते (पठ्),—कश्चित् उपजायते (प्रठ्),—
कश्चित् अन्वयी (अति);—अर्थोऽपि कश्चित् होयते (विलिप्तिः),—
कश्चित् उपजायते (पठिक्रिया),—कश्चित् अन्वयी (कर्तृत्वं चैकत्वं च) ।
तेन मन्यामहे यः शब्दो होयते, तस्य असौ अर्थः योऽर्थो होयते । यः शब्द
उपजायते तस्य असौ अर्थः योऽर्थे उपजायते । यः शब्दोऽन्वयी तस्य असौ
अर्थः योऽर्थोऽन्वयी ।

विषम उपन्यासः—वङ्गो हि शब्दा एकार्था भवन्ति । तद्वयथा इन्द्रः
शक्तः पुरन्दरः । एकश्च शब्दो वङ्गर्थः । तद्वयथा यथाः पादा भाषा इति ।
अथ किं न साधोयोऽर्थवता सिद्धा भवति । नापि ब्रूमोऽर्थवता न
सिध्यतीति । अर्थिता हि अर्थवता अन्वयव्यतिरेकाभ्यामेव । तत्र कुत
एतदयं प्रकृत्यर्थः अयं प्रत्ययार्थ इति । (Mahābhāṣya, 1—3, 9,)

Patanjali not only applies the Scientific Methods to the foundations of Grammatical Analysis, but also *by their means* establishes and elaborates the fundamental categories and concepts of Grammatical (and Philological) Science, *e. g.*, the concepts of action (क्रिया), agent (कर्ता), instrumental cause (करण साधकतमम्), end (निमित्त), origin (हेतु) limit (अवधि) substance (द्रव्य), quality (गुण), and genus (जाति); —also of the fundamental relations (at the bottom of all thought and *speech*)—the relations of Time (कालिकसम्बन्ध), of space (दिग्दिशसम्बन्ध), of causality (कार्यकारणभाव), of inherence (समवाय), of co-inherence (सामाण्याधिकरण्य), of substance and attribute (विशेषणविशेष्यभाव), of the sign and the signate (संज्ञासंज्ञिभाव), of mutual dependence (इतरितराश्रय);—an entire grammatical (and philological) apparatus, which will serve as a *point d'appui* for generations of philologists and grammarians to come.

ADDENDA.

(BY PRINCIPAL BRAJENDRANATH SEAL.)

Empirical Recipes from Varahamihira (circa 550 A.D.) relating to Chemical Technology.

A. Searing of hard rocks to enable them to be cut (or pulverised) (शिलादारण).

Sprinkle on the rock taken red-hot from the fire of Palasa and Tinduka wood (*Butea Frondosa* and *Diospyros Embryopteris*) :—(a) diluted milk, or (b) a solution of wood ashes (the ashes of the *Mokshaka* mixed with those of reeds), or (c) a decoction of (the fruit) of the jujube (*Zizyphus Jujuba*) kept standing for 7 nights in a mixture of whey, vinegar and spirits, in which *Kulattha* (*Dolichos Uniflorus* or *Biflorus*) has been steeped, or (d) a solution of the ashes of the *Neema* bark and leaves (*Azadirachta Indica*), the sesame pod, the resinous fruit of the *Diospyros Embryopteris*, and the *Guduchi* (*Tinospora Cordifolia*) with cow's urine. Repeat the process seven times (in the last case six times).

(Varāhamihira, *Vrihat-saṃhitā*, Chap. 33,
Sloka 112-117).

B. Hardening of steel (शस्त्रपात्र).

(1) Plunge the steel red-hot into a solution of plantain-ashes in whey, kept standing for 24 hours ; then sharpen on the lathe.

(2) Make a paste with the juice of the Arka (*Calotropis Gigantea*), the gelatine from the horn of the sheep, and the dung of the pigeon and the mouse ; apply it to the steel after rubbing the latter well with (sesame) oil. Plunge the steel, thus treated, into fire ; and when it is red-hot, sprinkle on it water, or the milk of the horse (or the camel or the goat), or ghee (clarified butter), or blood, or fat or bile. Then, sharpen on the lathe.

(Varáhamihira, खड्गशास्त्रम्,

chap. 49, slokas 23-26.

C. Preparation of cements (for rocks, metals, etc.) (बन्धन)—

Varáhamihira gives the following recipes among others. (1) First, prepare a levigated powder with lac, the resinous exudation of the *Pinus Devadara*, the *Balsamodendron Mukal*, the *Feronia Elephantum*, the kernel of the fruit of the *Ægle Marmelos* (the *bel*), the *Diospyros Embryopteris*, the *Neem* (*Azadirachta Indica*), the *Mhow* (*Bassia Latifolia*), the *Indian madder* (*Rubia Manjistha*), the *Phyllanthus Emblica*, and the resin of the *Sala tree* (*Shorea Robusta*), then make a decoction of this in 256 *Palas* of water reduced

by boiling to 32 Palas, and apply the decoction hot.

(2) The horns of cows, buffalos and goats, asses' hair, buffalo's skin, with *gavya* (cow's urine etc.), the Neem (*Azadirachta Indica*) and the *Feronia Elephantum*, similarly treated.

(3) A mixture of eight parts of lead, two of 'bell-metal' and one of brass, melted and poured hot (*Maya's cement*).

The first, it will be seen, has lac, gum and turpentine as principal ingredients, the second makes use of gelatine, and the third is a metallic cement.

D. Nourishment of Plants :—(from *Varāha-mihirīa*, Chap. 54, on वृक्षवृद्धे).

The most suitable ground to plant in is soft soil that has been sown with the *Sesamum Indicum*, and dug up or trodden over with the sesame in flower. Grafts should be smeared with cowdung. For transplanting, the plants should be smeared with ghee (clarified butter), sesame oil, the honey of the *Kshudra* variety of the bee, the oil of the *Usira* (*Andropogon Laniger* or *Andropogon Citrarum*), the *Vidanga* (*Embelia Ribes*), milk and cowdung. Trees should be planted at intervals of 20 or 16 cubits.

As a sort of general prophylactic, mud kneaded with ghee (clarified butter) and *Vidanga*, (*Embelia Ribes*) should be applied to the roots, after which

milk diluted with water should be poured. As a remedy against barrenness, a hot decoction should be made of Kulattha (*Dolichos Uniflorus* or *Biflorus*), Masha (*Phaseolus Roxburghii*), Mudga (*Phaseolus Mungo*), Tila (*Sesamum Indicum*), and Yava (barley); which, when cooled, should be poured round the roots.

To promote inflorescence and fructification, a mixture of one A'dhaka (64 palas) of sesame, two A'dhakas (128 palas) of the excreta of a goat or sheep, one Prastha (16 palas) of barley powder, one Tula (100 palas) of beef, thrown into one Drona (256 palas) of water, and standing over for seven nights, should be poured round the roots of the plant. The measures given are for one plant.

To ensure inflorescence, etc., the seed before being sown should be treated as follows :—The seeds should be taken up in the palm greased with ghee (clarified butter), and thrown into milk;—on the day following, the seeds should be taken out of the milk with greased fingers, and the mass separated into single seeds. This process is to be repeated on ten successive days. Then the seeds are to be carefully rubbed with cowdung, and afterwards steamed in a vessel containing the flesh of hogs or deer. Then the seeds are to be sown with the flesh, with the fat of hogs added, in a soil previously prepared by being sown with
and dug up or trodden down.

To ensure the formation of *Ballaris* (i.e., sprouting and the growth of luxuriant stems and foliage), the seeds should be properly soaked in an infusion of powdered paddy, *Masha* (bean), sesame and barley mixed with decomposing flesh, and then steamed with *Haridra* (turmeric). This process will succeed even with the *Tintidí* (*Tamarindus Indica*). For the *Kapittha* (*Feronia Elephantum*), the seeds should be soaked for about two minutes (lit. such length of time as it would take one to make a hundred rhythmic claps with the palms तालपाद in a decoction of eight roots (*A'sphota*, *A'malakí*, *Dhava*, *Vásika*, *Vetasa*, *Suryyavalli*, *Syáma* and *Atimukta*, i.e., the Jasmine, the myrobalan, the *Grislea Tomentosa*, the *Justicia Ganderussa*, the *Calamus Rotang*, the *Gymandropsis Pentaphylla*, the *Echites Frutescens*, and the *Dalbergia Oujeinensis*) boiled in milk. The seeds should then be dried in the sun. This process should be repeated for thirty days. A circular hole should be dug in the ground, a cubit in diameter and two cubits deep, and this should be filled with the milky decoction. When the hole dries up, it should be burnt with fire, and then pasted over with ashes mixed with ghee and honey. Three inches of soil should now be thrown in, then the powder of bean, sesame and barley, then again three inches of soil. Finally, washings of fish should be sprinkled, and the mud

should be beaten and reduced to a thick consistency, then the seed previously prepared should be placed in the hole under three inches of soil, and fish-washings poured. This will lead to luxuriant ramification and foliage, which will excite wonder. The Agnipurāna adds that the mango is specially benefited by cold fish-washings (मत्स्योदकेन शीतेन चास्त्राणां सेक इत्यते—उच्चायुर्ज्ज्वेद, Agnipurāna). It will be seen that these elaborate recipes are empirical contrivances for supplying the requisite nitrogen compounds, phosphates and bacteria, these being potentially contained in the mixtures and infusions prescribed.

SANSKRIT TEXTS.

Extracts from RASARATNAKARA.

नागाज्जुन-विरचितात्

रसरत्नाकरादुद्धृताः श्लोकाः ।

अथ महारसशोधनं व्याख्यास्यामः ।

किमत्र चित्रं यदि राजवत्तेकं

श्रीरौप्यपुष्पाग्रसेन भावितम् ।

सितं सुवर्णं तरुणार्कसन्निभं

करोति गुञ्जाशतमेकगुञ्जया ॥ १ ॥

राजावर्त्तशोधनम् ।

किमत्र चित्रं यदि पीतगन्धकः

पलाशनिर्व्यासरसेन शोधितः ।

आरण्यकैरुत्पलकैस्तु पाचितः

करोति तारं त्रिपुटेन काञ्चनम् ॥ २ ॥

गन्धकशुद्धिः ।

किमत्र चित्रं रसको रसेन

* * * * *

क्रमेण कृत्वाम्बुधरेण रक्षितः

करोति शुद्धं त्रिपुटेन काञ्चनम् ॥ ३ ॥ *

रसकशोधनम् ।

किमत्र चित्रं दरदः सुभावितः

पयेन[†] मेथ्या बहुशोऽम्बुधरेण ।

सितं सुवर्णं बहुधर्मभावितं

करोति साक्षाद्वरकुङ्कुमप्रभम् ॥ ४ ॥

दरदशुद्धिः ।

कुलत्यकोद्वक्त्राये नरमूत्रेण पाचयेत् ।

वेतसाद्यम्बुधरेण दत्त्वा क्षारं पुटत्रयम् ॥ ५ ॥

किमत्र चित्रं कदलीरसेन

सुपाचितं सूरणकन्दसंस्थम् ।

* Agrees nearly with Rasárnava ; cf. Vol. I. Sans. Texts, p. 13.

† पयसा is the correct form.

वातारितैलेन घृतेन ताप्यं
पुटेन दग्धं वरशुद्धिमिति ॥ ६ ॥

माक्षिकशोधनम् ।

द्विगुणा विमला पथ्या रन्भातोयेन संयुता ।
लवणैर्वर्ध*दुग्धेन ताम्रपत्राणि लेपयेत् ॥ ८ ॥
अग्नौ सन्तप्य निर्गुण्डीरससिक्तानि सप्तधा ।
मासान् वसुरसेनैव शुल्वशुद्धिर्भविष्यति ॥ १० ॥

परतः सर्व्वलोल्लशोधनम् ।

अश्लवेतसधान्यान्ममेधोतोयेन शुध्यति ॥ ११ ॥

विमलशुद्धिः ।

चपलाद्या धातवः सर्व्वे जम्बोररसभाविताः ।
शोधितास्त्रिदिनं पञ्चमृत्तिकाभस्मलावणैः ।
संयुताः संशोधयन्ति पुटपाकेन काञ्चनम् ॥ १२ ॥
हेमशोधनम् ।

नागेन क्षारराजेन ध्वापितं शुद्धिमृच्छति† ।

* The text reads वर्ध, which is incorrect.

† This verse also occurs in Rasarnava.

तारं त्रिवारनिक्षिप्तं पिशाचीतैलमध्यगम् ॥१३॥

तादृशुद्धिः ।

अहो नु चित्रं पृथिवीभवेन

क्षारेण मेषीपयसा घृतेन ।

तैलेन शुद्धं द्रुतषोडशांशं

भवेच्च शुद्धं शशिशृङ्गसन्निभम् ॥१४॥

मोक्षमारोटपालाश-क्षारगोमूत्रभाषितम् ।

वज्रकन्दशिखाकल्क-फलमूलसमन्वितम् ॥२३॥

तत्कल्कं कण्टकं साक्षाच्चूर्णं वैक्रान्तसम्भवम् ।

सारधेय* समायुक्तं मेषशृङ्गीद्रवान्वितम् ॥२४॥

पिण्डितं मूकमृषास्थं धामितच्च दृढाग्निना ।

तत्रैव पतते सत्त्वं वैक्रान्तस्य न संशयः ॥२५॥

वैक्रान्तमत्त्वम् ।

क्षौद्रं गन्धर्व्वतैलं सघृतमभिनवं

गो रसं मूत्रकञ्च

* These couplets also occur in R. R. S., with this difference that in the latter नवसार has been substituted for सारधेय.

भूयो वातारितैलं कदलिरसयुतं
 भावितं कान्तितप्तम् ।
 मूषां कृत्वाम्निवर्णामरुणकरनिभां
 प्रक्षिपेन्माक्षिकेन्द्रं
 सत्त्वं नागेन्द्रतुल्यं पतति च सहसा
 सूर्यवैश्वानराभम् ॥ २५ ॥ *
 महाहृत्कार्कशीराभ्यां स्त्रीस्तन्येन सुभावितम् ।
 मूषायामग्निवर्णायां द्रवेत्ताप्यं न संशयः ॥ २६ ॥
 कङ्कुष्ठटङ्गणाभ्याश्च ताप्यं स्त्रीस्तन्यमर्हितम् ।
 पश्चात्सत्त्वं निपतति सत्त्वं मूषा तु भग्नवत् ॥ २७ ॥
 काञ्चिकं बहुशस्त्रिणं ताप्यचूर्णं कटुत्रिकम् ।
 कृत्वाम्बुमधुभ्यां पक्वं वज्रपायसभावितम् ॥ २८ ॥
 गृहधूमं घृतं क्षौद्रं संयुतं पुनरेव च ।
 धामितं मूकमूषायां शशिशल्बनिभं भवेत् ॥ २९ ॥
 कदलौरसशतभावितं घृतमध्येरुण्डतैलपरिपक्वम् ।
 ताप्यं मुञ्चति सत्त्वं रसकक्षैव त्रिसङ्घाते ॥ ३० ॥
 माक्षिकसत्त्वपातनविधिः ।

* Cf. Basárnava, Vide Sans. Texts, Vol. I., p. 12

चारुस्नेहैव धान्धान्ते रसकं भावितं बहु ।
 ऊर्षां लाक्षा तथा पथ्या भूलता धूमसंयुतम् ॥ ३१ ॥
 मूकमूषागतं धातं टङ्कणेन समन्वितम् ।
 सत्त्वं कुटिलसङ्काशं पतते नात्र संशयः ॥ ३२ ॥ *
 रसकसत्त्वम् ।

विमलं शिथलीयेन काक्षीकासौसटङ्कणैः ।
 वज्रकन्दसमायुक्तं भावितं कदलीरसैः ॥ ३५ ॥
 माक्षीकचारसंयुक्तं धामितं मूकमूषके ।
 सत्त्वं चन्द्रार्कसङ्काशं पतते नात्र संशयः ॥ ३६ ॥ †
 विमलसत्त्वम् ।

दरदं पातनायम्बे पातितञ्च जलाशये ।
 सत्त्वं सूतकसङ्काशं जायते नात्र संशयः ॥ ३७ ॥
 दरदसत्त्वम्

गन्धकश्च प्रभावेण सत्त्वभूयं स्वभावतः ।

* Cf. Rasārṇava, Benares MS. V. 37—38.

† Cf. Sans. Texts, Vol. I. p. 12. B. R. S. Bk. ii, 103—104.

ततः ख्यातं महासत्त्वं रसेन्द्रस्य समं ततः ॥ ३८ ॥

अभ्रकादिसत्त्वपातनविधिः ।

* * * *

एक एव महाद्रावो पार्व्वतोनाथसम्भवः ।

किं पुनस्त्रिभिः संयुक्तो वेतसाम्नाम्नकाक्षिकैः ॥ ५० ॥

मुष्काफलानि समाहं वेतसाम्नेन भावयेत् ।

पुटपाके ततश्चूर्णे द्रवते सलिलं यथा ।

कुर्वते योगराजोयं रत्नानां द्रावणे परम् ॥ ५१ ॥

अभ्रकादिद्रुतपातनविधिः ।

तालेन वङ्गं दरदेद तीक्ष्णं

नागेन हेमं शिलाया च नागम् ।

गन्धाश्मना चैव निहन्ति शुल्बं

तारश्च माक्षीकरसेन हन्यात् ॥ ५२ ॥

* * * *

शुल्बम् अजाक्षीरसुगन्धकेन

तारं क्षुहीक्षीरसुमाक्षिकेण ।

यद्यस्य धातोर्विहितश्च युक्तं

निहत्यघातं कथितश्च तीक्ष्णैः ॥ ५४ ॥

मृतानि लोहानि रसीभवन्ति
 रसेन युक्त्यामयनाशनानि ।
 अभ्यासयुक्ता पलितादिनाशं
 कुर्वन्ति तेषाञ्च जराविनाशम् ॥ ५५ ॥

इति नागार्जुनविरचिते रसरत्नाकरे वज्रमारण-
 सत्त्वपातन-अभ्रकादिद्रावण-वज्रलोह-
 मारणाधिकारो नाम द्वितीयः ।

अथातो रसबन्धाधिकारं व्याख्यास्यामः ।

जम्बीरजेन नवसारघनाम्नवगैः
 क्षाराणि पञ्च लवणानि कटुत्रयञ्च ।
 शिग्रूदकं सुरभिसुरणकन्द एभिस्-
 संमर्दितो रसनृपश्चरतेष्टलोहान् ॥ १ ॥

चारणजारणविधिः ।

प्रज्ञापारमिता निशीथममये स्वप्ने प्रसादीकृतं
 नाञ्चा तीक्ष्णमुखं रसेन्द्रममलं नागार्जुनप्रोदितम् ॥ ४ ॥

रसं हेमसमं मर्द्यं पौठिकागिरिगन्धकम् ।
 द्विपदीरजनीरन्धां मर्दयेत् टङ्कणान्विताम् ॥३०॥
 नष्टपिष्टञ्च मुष्कञ्च चन्धमूर्ध्ना निधापयेत् ।
 तुषाक्षवपुटं दत्त्वा यावद्गन्धत्वमागतः ॥३१॥
 भक्षणात्काधकेन्द्रसु दिव्यदेहमवाप्नुयात् ॥३२॥

* * * *

गर्भयन्त्रं प्रवक्ष्यामि पौठिकाभस्मकारकम् ।
 चतुरंगुलदोर्वेण विस्तारेण च त्राङ्गुलाम् ॥३२॥
 मूर्धां तु मृन्मयीं कृत्वा सुदृढां वर्तुलां बुधः ।
 विंशभागन्तु लोहस्य भागमेकं तु गुग्गुलोः ॥३३॥
 सुश्लक्ष्णं प्रेषयित्वा तु तोयं दत्त्वा पुनः पुनः ।
 मूर्धालेपं दृढं बद्ध्वा लोणार्धमृत्तिका बुधः ॥३४॥
 कर्षे तुषाग्निना भूमौ मृदुस्वेदेन स्वेदयेत् ॥३५॥
 सूतकस्य पलं गृह्णान् तुर्यांशं साक्षकं विषम् ।
 तत्समं गन्धकं शुष्कं चूर्णं कृत्वा विनिक्षिपेत् ॥३६॥
 कृत्वा कज्जलिकामादौ पलं दत्त्वा च गन्धकम् ।
 घृतपक्वञ्च तच्चूर्णं पचेदायसभाजने ॥३७॥

यावद्वपत्वमायाति तत्क्षणात् तं विनिश्चिपेत् ।

पुटे वा कदलीपत्रे सिद्धं पर्पाटकारसम् ॥८६॥

द्वितीयपपंटीरसः ।

प्रणिपत्य सर्व्वबुद्धान्

(सद्बोधान्) सकलदोषनिर्मुक्तान् ।

वक्ष्ये सर्व्वद्वितायं

कक्षापुटं सर्व्वसिद्धिकरम् ॥

श्रीशैलपर्व्वतस्थायी सिद्धो नागार्जुनो महान् ।

सर्व्वसत्त्वोपकारी च सर्व्वभाग्यसमन्वितः ॥

प्रार्थितो ददते शीघ्रं यच्च पश्यति यादृशम् ।

दृष्ट्वा त्यागश्च भोगश्च सूतकस्य प्रसादतः ।

सर्व्वसत्त्वामयावेधी स्वरसेन तथैव च ॥

तेषां मध्ये प्रधानश्च रत्नघोषः प्रचारकः ।

कृताञ्जलिपुटो भूत्वा नागार्जुनपुरः स्थितः ।

पृच्छते रसकर्माणि विद्यादानं ददस्व मे ॥

श्रीनागार्जुन उवाच—

साधु साधु महाप्राज्ञ तुष्टोऽहं भक्तवत्सलः ।

कथयामि न सन्देहस्तत्त्वया परिपृच्छताम् ॥

वलीपलितनामश्च तथा कालस्य ध्वंसनम् ।

यथा लोहे तथा देहे क्षमते नात्र संशयः ॥

* * * *

सत्त्वानां भोजनार्थाय साधिता वटयक्षिणी ।

द्वादशानि च वर्षाणि महाक्लेशः कृतो मया ॥

तत्कालदृष्टद्रव्याणां दिव्या वाणी मया श्रुता ।

अदृष्टप्रार्थिता पञ्चादृष्टा त्वं भव साम्प्रतम् ॥

श्रीवटयक्षिण्युवाच—

साधु साधु महासिद्ध * * *

किञ्चिन्प्रार्थय मे सिद्ध तत्सर्वं प्रददाम्यहम् ॥

श्रीनागाजुं न उवाच—

यदि तुष्टासि मे देवि सर्व्वदा भक्तिवत्सले ।

दुर्लभं त्रिषु लोकेषु रसबन्धं ददस्व मे ॥

शालिवाहन उवाच—

सुवर्णरत्नभाण्डारं कुमारी मदसुन्दरी ।

निवेदितो मयात्मा मे आदेशो देवि दीयताम् ॥

साधु साधु महाप्राज्ञ ममादेशप्रपालक ।

साधयामि न सन्देहो युष्मत्सत्येन साधकम् ॥

पुनरन्यं प्रवक्ष्यामि माण्डव्येन यथा कृतम् ।
 रसोपरसयोगेन सिद्धं सूतं सुसाधितम् ॥
 विहगुत्थायनं नागं यक्षार्थकाञ्चनं कृतम् ।

* * * *

शास्त्रं वशिष्ठमाण्डव्यं गुरुपाशेन यथा श्रुतम् ।
 तदहं सम्प्रवक्ष्यामि साधनञ्च यथाविधि ॥
 सहायशोभनाः प्राज्ञा निरालम्बा दृढव्रताः ।
 कुलीनाः पापहीनाश्च साधयन्ति जितेन्द्रियाः ॥
 कोष्ठिका वक्रनालश्च गोमयं सारमिन्धनम् ।
 धमनं लोहपत्राणि शीषधं काष्ठीकं विडम् ॥
 कन्दराणि विचित्राणि * * *
 सर्वमेलयनं कृत्वा ततः कर्म समारभेत् ॥

रत्नघोष उवाच—

साधयित्वा प्रयत्नेन कोटिवेधी महारसः ।
 शरीरेण विनैतेन सर्व्वं भवति निष्फलम् ॥

नागार्जुन उवाच—

कथयामि न सन्देहः साकाण्डेन यथा कृतम् ॥
 आर्द्रत्वञ्च घनत्वञ्च चापस्यं गुरुतेजसः ।

यस्यैतानि न दृश्यन्ते तं विद्याङ्गसूतकम् ॥
 नानावर्णं भवेत्सूतं विज्ञाय घनचापलम् ।
 लक्षणं दृश्यते यस्य मूर्च्छितं तं वदन्ति हि ॥
 गुरुत्वमरुणत्वं वा तेजो भास्करसन्निभम् ।
 अग्निमध्ये यदा तिष्ठेत् खोटवन्धस्य लक्षणम् ॥*

अथातो रसेन्द्रमङ्गलानि यन्त्रविधिः ।

शिलायन्त्रं, पाषाणयन्त्रं, भूधरयन्त्रं, वंशयन्त्रं,
 नलिकायन्त्रं, गजदन्तयन्त्रं, दोलायन्त्रं, अधःपातन-
 यन्त्रं, भुवःपातनयन्त्रं, पातनयन्त्रं, नियामकयन्त्रं,
 गमन(?)यन्त्रं, तुलायन्त्रं, कच्छपयन्त्रं, चाक्रीयन्त्रं,
 बालकायन्त्रं, अग्निसोमयन्त्रं, गन्धकत्राहिकयन्त्रं,
 मूषायन्त्रं, इण्डिकायन्त्रं, कम(?)भाजनयन्त्रं घोषा-
 यन्त्रं, गुहाभ्रकयन्त्रं, नारायणयन्त्रं, जालिकायन्त्रं,
 चारणयन्त्रम् ।

अथ प्रवक्ष्ये सुगुरुपदेशान्

यः पाटलाख्यस्य रसस्य वृद्धः ।

* Cf. Rasārṇava. Vide Sans. Text, Vol. I. pp. 17—18.

यस्य प्रभावात् क्षयमेव
 क्षरादिकुष्ठामयनिषङ्गः स्यात् ॥
 निक्षिप्य क्षुब्धे त्रिपुरान्तकस्य
 बीजं दिशुर्दार्ढ्यपलप्रमाणम् ।
 क्रायेण तस्य त्रिपुरोद्धवेन
 सम्मर्दयेत् त्रिदिनानि यावत् ॥
 कन्यारसेन त्रिदिनं ततश्च
 सप्तार्चिषा चाथ दिनत्रयञ्च ।
 चूर्णेस्त्रिकाया रजनोरजेन*
 सम्मर्दितं तम् उषतोयधीतम् ॥
 क्षौद्रि प्रमाणान्धथ सप्तमञ्च
 सम्पातयेत् पातनयन्मयोगात् ।
 सम्पातितो निर्मलतामुपैति
 सर्व्वप्रयोण्योऽपि हितं प्रशस्तम् ॥
 पलं समादाथ रसस्य तस्य
 शुक्लस्य शुद्धस्य च कर्षमेकम् ।

* The text seems to be incorrect.

कृत्वाष्टपिष्टौ विधिवत्तैयोश्च
 गन्धाश्मचूर्णं द्विगुणञ्च देयम् ॥
 द्रुतप्रयोगेण विपाच्य पञ्चान्-
 निक्षिप्य खण्डे परिमर्दितञ्च ।
 निष्कञ्च मात्रां त्वमृतस्य दत्त्वा
 गुप्ताप्रमाणा गुटिका च कार्य्या ॥
 श्रीलोकनाथस्य विभोः प्रसादात्
 ज्ञातं मया पोटलिकाविधानम् ॥
 * * * * *
 इति रसेन्द्रमङ्गलं समाप्तम् ।

Extracts from RASAHRIDAYA.

भगवद्गोविन्दपादविरचितात्

रसहृदयादुद्धृताः श्लोकाः ।

A = MS. from Nepal.

B = MS. from India Office Library, with a commentary, named "Bálanvayabodhiká."

C = MS. from Benares.

द्वितीयपटलादुद्धृताः श्लोकाः ।

[टीका—मूर्च्छितरसस्य उत्थापनसंस्कारमाह—]

अमुना विरेचनेन हि सुविशुद्धो नागवक्त्रपरिसुक्तः ।

सूतः¹ पातनयन्त्रे समुत्थितः² काञ्चिके³ काथात्³ ॥

[टीका—अथ मूर्च्छितरसस्य पञ्चमोद्दिष्टपातनसंस्कारं स्पष्टयन्माह—]

(1) A reads पात्त, which makes the sentence incomplete and the metre defective.

(2) A reads सुविशुद्धं, which is a tautology as well as a grammatical error.

(3) काञ्चिकेन काथात् is the variant in B. This is a defective metre.

कृत्वा तु सुखपिष्टी¹ निपात्यते नागवक्त्रशङ्कातः² ।
 तस्मिन् दोषान् मृत्ना³ निपतति शुद्धस्तथा सूतः⁴ ॥
 अष्टाङ्गुलविस्तारं⁵ देर्घेण⁶ दशाङ्गुलं त्वधोभाण्डम् ।
 कण्ठादधः समुच्छ्रितचतुरङ्गुलकज्जलाधारम्⁷ ॥
 अन्तःप्रविष्टतलभाण्डं⁸ वदनजलमग्ननिजमुखप्राग्ना⁹ ।
 उपरिष्ठाच्चिपिटपटी¹⁰ देयोदरषोडशाङ्गुलविशाला ॥

(1) A reads सुखपिटिम्.

(2) निपात्यते नागवक्त्र सदोष is the reading in A, which is incorrect as well as defective metre.

(3) A reads सुल दावाख्यज्ञा.

(4) A reads शुद्ध, which is a tautology as well as a grammatical error.

(5) B reads अष्टाङ्गुलश्च विशीर्षे, which destroys the metre.

(6) B reads देव्यं च तु. wherein तु is redundant.

(7) B reads सम तच्चतुरङ्गुलं कृतजलवारा, which mars the metre.

(8) A reads अन्तःप्रविष्टतलभाण्डं, which is a defective metre.

(9) B reads प्राग्नाः, which is grammatically incorrect.

(10) A has उपरिष्ठाच्चिपुटपुटित, which is senseless.

तस्मिन्धीर्घभाण्डे¹ निपातितः सकलदोषनिर्मुक्तः² ।
 सुतरां भवति रसेन्द्रो जीर्णवासोऽपि पात्रोऽसौ³ ॥
 कृत्वाय⁴ नष्टपिष्टं त्रिफलाशिखिशिग्रुराजिकापटुभिः ।
 संलेप्य चोर्ध्वभाण्डं दीप्तैरपलैरधः पात्रः⁵ ॥
 अथवा दीपकयन्त्रे⁶ निपातितः सकलदोषनिर्मुक्तः ॥
 कच्छप्रयन्त्रान्तर्गत⁷ मृन्मयपीठस्य दीपिकासंस्त्रः ।
 यस्मिन्निपतति सूतः प्रोक्त⁸ तद्दीपिकायन्त्रम् ॥

(1) A reads तस्मिन् दूर्ध्वभाण्डे, which is incorrect.

(2) निपातितसकलनिर्मुक्तः, an incomplete variant in A.

(3) A has an incorrect reading—वासुजीर्णपपात्रासौ.

(4) This verse and the next two are not found in B.

(5) A reads रपरैरधःप्राप्ता, which has no sense.

(6) A has दीपनयन्त्रे.

(7) A reads कच्छप्रयन्त्रे चान्तर्गत, which is grammatically incorrect.

(8) The word तत् is not found in A, thus making the metre defective.

सप्तमः पटलः ।

[टोका—अथ विड़विधानमारभ्यते—]

आसं न मुञ्चति न वाञ्छति तच्च भूयः

काञ्चिद्गुणान्¹ भजति² नित्यमनुक्तमात्रात्³ ।

यज्जीर्यते प्रचुरकेवलवक्रियोगात्

तस्माद्विड़ैर्मुनिविड़ैः सह⁴ जारणा स्यात् ॥

[टोका—विड़विधानमाह—]

सौवर्चलकटुकत्रयकाङ्क्षे⁵ काशीसगन्ध कैश्च विड़ैः ।

शिष्यो रसशतभाव्यैस्तान्मदलान्यपि हि जारयति⁶ ॥

[टोका—विड़ान्तरमाह—]

(1) A reads काञ्चिद्गुणान्, which is incorrect.

(2) B reads व्रजति.

(3) अनुक्तविमुक्तमात्रात् is the variant in A,

(4) A reads मुनियतैरिषु, which seems to be incorrect.

मुनिविड़ैः means by seven विड़s, mentioned below.

(5) A reads काञ्चि, which is incorrect.

(6) A has शिष्यरसशतभावितम् । तस्य द्वावपि हि जारयति, which is incorrect as well as defective in metre.

सर्वाङ्गदग्धमूलकप्रतिगलितं सुरभिर्मूत्रेण¹ ।
 शतभाष्यं बलिवसया² तत्क्षयतो जायते हेम ॥
 [टीका—अथ चारुचक्षुगुल्मीषधीराह—]
 कदलीपलाशतिल³निष्कनकसुरदालिवासुकैरुष्णाः ।
 वर्षाभूहृषमोक्षक⁴सहिताः चारा यथा लाभम् ॥
 [टीका—चारविधानमाह—]
 आनीय चारुचक्षान् कुसुमफलशिफा-
 त्वक्पलाशैरुपेतान्⁵
 कृत्वा⁶ खण्ड्यस्तान्⁶ विपुलतरशिला-
 पिष्टपात्रातिशुष्कान्⁷ ।

(1) सर्वाङ्गं दग्धमूलकं रसप्रतिप्रतिगलितसुरभिर्मूत्रेण, a variant in A, which has no metre at all.

(2) A reads शतभाषितरसवज्रया, which has no sense.

(3) तिल is not found in B.

(4) A reads माक्षीक, which seems to be incorrect.

(5) कुसुमफलश्यापचकटेरुपेतान् is an incorrect text in A.

(6) A reads कृत्वा तत्क्षयस्तान्, which is incorrect.

(7) A has विपुलतरशिलापुष्टमानातिशुष्कान्.

दग्धं काण्डैस्त्रिस्तानां करिसुरभिहया-
 शोभिरासाव्य वक्त्रैः¹
 भक्ष्यं त्वज्जा जलं तत्² अदुग्धिनि पचेत्
 हंसपाकेन भूयः³ ॥

[टीका—चारजलपाकलक्षणमाह—]

तच्छब्दमात्रं हि सवायवदुदुदान्
 यदा विधत्ते⁴ क्षणभङ्गरान् वदन् ।
 तदा क्षिपेत् क्षूण्य⁵ हिङ्गुगन्धकं
 चारयं सप्तवसानि मूखगम्⁶ ॥

- (1) A reads करिसुरभिहयीद्राजकानां च मूचे.
- (2) A reads तं. which is incorrect.
- (3) A reads वावत्.
- (4) A reads erroneously यथा वदते.
- (5) A reads क्षिपेत्क्षूण्य. B reads क्षिपेन्क्षूण्य. Both the readings are incorrect.
- (6) A has चारयितयं पटुक्षयं मूनिखगं, which mars the metre.

द्रव्याणि संमिश्र्य निवृत्य भूतले
व्यवस्थितान्यस्त्रिकटोरिकापुटे¹ ।
संस्थापयेत् सप्तदिनानि धान्यगं
ततः प्रयोज्यं रसजारणादिकम् ॥

[टोका—जारणायौ चारविधानमाह—]
जम्बीरबीजपूरकं² चाङ्गेरोवेतसाम्बसंयोगात् ।
क्षारा भवन्ति नितरां गर्भद्वृत्तिजारणे शस्ताः³ ॥

[टोका—रसे विडयोजनमाह—]
विडमधरोत्तरमादौ दत्त्वा सूतस्य चाष्टमांशेन⁴ ।
कुर्यात्क्षारणमेवं क्रमक्रमाद्वर्धयेदग्निम्⁵ ॥

(1) A reads व्यवस्थितान् सस्त्रिकठारिकामुखे । B reads व्यवस्थितशस्त्रकठोरिकापुटे ।

(2) A reads बीजपूरकं, which is incorrect. The word बीजपूर is not found in B.

(3) गर्भद्वृत्तिजारणा शस्ता is an incorrect variant in A.

(4) A has दत्त्वा सूतं चाष्टमांशेन, which is not correct as it destroys the metre as well as the sense.

(5) A reads वर्धयेदग्निः, which is grammatically incorrect.

अष्टमः पटलः ।

[टीका—अथ रसरागोऽभिधास्यते—

अभ्रकजीर्णस्य छायाविशेषमाह—]

जीर्णाभ्रको¹ रसेन्द्रो

दर्शयति² घनानुकम्पिनीं छायाम्³ ।

कृष्णां रक्तां पीतां

सितां⁴ तथा सङ्करं मिश्राम्⁵ ॥

(1) A reads जीर्णाभ्रक, which mars the metre.

(2) A reads दुर्दृश्यति, which is incorrect.

(3) घनानुकम्पिनी छाया is the variant in A. घनानुकम्प-
छाया is the variant in B. Both the readings seem to be
incorrect.

(4) कृष्णं रक्तं पीतं शितं is the reading in A, which is
incorrect.

(5) A reads ददा संकरीर्क्षिणः, which is incorrect.

[टीका—अभ्यक्तयोगाहर्णविशेषमाह—]

सप्तधाभ्यक्तेषु बलवत्^१ सितरागैर्युज्यते^२ रसेन्द्रसु ।

शेतै रक्तैः पीतैः वज्रैः खलु वर्चतो ज्ञेयः^३ ॥

[टीका—अथ रक्षितरसप्रशंसामाह—]

अथ निजमेव हि वर्ण^४

न जहाति यदा स रज्यते^५ रागेः ।

क्रमशो हि भक्ष्यमाणो^६

निर्निर्ज्ञो^७ रक्ष नं कुर्वते ॥

(1) शेतधाभ्यक्तेषु बलवान् is the variant in A, which is incorrect.

(2) A reads सितरागेः पूर्यते.

(3) A has नविपुतो ज्ञेयं, which has no clear sense. B has वज्रवर्चतो ज्ञेयः, which mars the metre.

(4) B reads अथ निजकर्मवर्णं, which is not correct.

(5) A reads यदा रसजीर्यते, which is grammatically incorrect.

(6) A reads भक्ष्यमाणा, which is incorrect. B reads क्रमशो वक्ष्यमाणो, which is also incorrect.

(7) A reads नारक्तो.

[टीका—अभ्रसत्त्वादौनां योगे रसे व्यवस्थामाह—]
 बलमास्तेभ्रकसत्त्वे आरचरागाः प्रतिष्ठितास्तीक्ष्णो^१ ।
 बन्धस्य सारलोहे^२ सारणमथ^३ नागवक्त्राभ्याम्^४ ॥

[टीका—सर्व्वकरणं तीक्ष्णमाह—]
 क्रामति तीक्ष्णेन रसः तीक्ष्णेन^५ जीर्य्यते क्षणाद्वासः^६ ।
 हेनो योनिस्तीक्ष्ण^७ रागान् गृह्णाति तीक्ष्णेन ॥

[टीका—तीक्ष्णहृङ्गुलयोगेन गुणाधिक्यमाह—]
 तदपि च दरदेन हतं हत्वा माक्षीकेण रविसहितम्^८ ।
 वासितमपि वासनया घनवच्चार्थश्च जार्थश्च ॥

- (1) A reads erroneously प्रतिष्ठिता लीक्षा.
- (2) A reads सारचलाहेः, which is incorrect.
- (3) A reads क्रामचमथ.
- (4) B reads नागवक्त्रमतः,
- (5) A reads तीक्ष्णे च.
- (6) A reads वासि, which is incorrect
- (7) A reads जीतिस्तीक्ष्ण, which has a defective metre
- (8) B has omitted हत्वा माक्षीकेण रवि.

[टौका—तीक्ष्णवदेनानाह—]

कान्तं वा तीक्ष्णं वा काङ्क्षीं वा वज्रसस्यक वापि¹ ।

एकतमं सर्व्वं वा रसरजने सङ्करोऽभीष्टः² ॥

[टौका—स्ने स्ने विकारे वक्ष्यमाणमाह—]

कुटिले³ बलमप्यधिकं रागस्तीक्ष्णे तु पन्नगे स्नेहः⁴ ।

रागस्नेहबलानि तु कमले शंसन्ति धातुविदः⁵ ॥

सर्व्वैरेभिर्लोहैर्माद्विकसहितैर्मृतिस्तथा गर्भे ।

विद्ययोगिन तु जीर्णो रसराजो विशति लोहेषु ॥⁶

[टौका—रसबन्धानां मारणे विधानमाह—]

तालक⁷दरदशिलाभिः स्नेहचाराम्बलवणसहिताभिः ।

(1) काङ्क्षीं वा वज्रसस्यकादीनां, a variant in B.

(2) रसेपि हि रसायने विद्यात्, a variant in A.

(3) This is not found in B.

(4) A reads erroneously पन्नगस्नेह.

(5) A reads धातुविधं, which is incorrect.

(6) This sloka is not found in B.

(7) A reads तारक.

समकद्विगुणत्रिगुणान् पुटो वहैदङ्गशस्त्रादीन्¹ ॥

[टोका—पुटितधातुक्त्यमाह—]

रक्तस्नेहनिषेकैः सेकं² कुर्याद्रसस्य पिष्टिरियम्³ ।

चारणजारणमात्रात् कुरुते रसमिन्द्रगोपनिभम् ॥

[टोका—मुख्यत्वेन ताम्रप्रशंसनमाह—]

अथवा⁴ केवलममलं कमलं दरदेन वापितं कुरुते

त्रिगुणं जीर्णं जीर्णं⁵ लाक्षारससन्निभं सूतम् ॥

[टोका—विध्यन्तरमाह—]

रक्तगणगलितपशुजल-

वहु⁶भावितताप्यगन्धकशिलानाम्⁷ ।

(1) निवाहयेदङ्गः शस्त्रादीन्, a variant in A, which has a defective metre.

(2) B reads शेष.

(3) A reads क्वाष्टिर्द्य, which is incorrect.

(4) B reads erroneously अथ.

(5) त्रिगुणं हि जीर्णंजीर्णं, a variant in B.

(6) The word बहु is omitted in B, which renders the metre defective.

(7) A reads गन्धकशिलाभिः.

एकेन वापितमृत¹

कमलं रञ्जयति रसराजम् ॥

[टोका--रागाधिकारि-गन्धकादीनाह--]

वाह्यो गन्धकरागो² विलुलितरागो³ मनःशिलाताले ।

माक्षीक⁴सत्स्वरसकौ जावेती⁵ रञ्जने शस्तौ ॥

[टोका--प्रधानयोः ताम्रखर्परयोः क्षत्यमाह--]

क्रमवृद्धैः रविरसकैः⁶ संशुद्धो मूकमूषिकाभातः⁷ ।

(1) A reads वापितमृत, which seems to be incorrect.

(2) A reads गन्धकराग, which is incorrect.

(3) A reads विलुलितरागो. B reads विलुलितरागिण. Both the readings are grammatically incorrect.

(4) B reads माक्षिक, which mars the metre.

(5) B reads द्रव्ये हि, which seems to be incorrect.

(6) A reads क्रमवृद्धै रविरसकैः. B reads क्रमवृद्धौ रविरसकौ.

We have adopted the above reading after collating the texts.

(7) मूषिकासुनिभातः, a variant in A, which mars the metre. मूकमूषिकाभातौ, a variant in B.

विगुणं जीर्णो जीर्णो¹ हेमाभो जायते² सूतः ।

[टीका—अभ्रकयोगमाह—]

अथ³ क्षणाभ्रकचूर्णं पुटितं रत्नं भवेत्तथा⁴ शकलम् ।

विगुणं जीर्णो जीर्णो⁵ हेमद्वतिसंनिभः सूतः⁶ ॥

[टीका—स्वर्णमारणमाह—]

विगुणेन मायिकेन तु कनकं च सृतं रसतालयुतम्⁷ ।

पटुसहितं तत् पक्वं हृष्टिकया यावदिन्द्रगोपनिभम् ॥

(1) A reads जीर्णे जीर्णे. B reads जीर्णो जीर्णो.

(2) A reads धृतिहेमनिभो भवेत्, (धृति—द्रुत). B reads हेमवर्णाभो जायते, which mars the metre.

(3) A reads क्षणा, which destroys the metre.

(4) A omits तथा.

(5) A reads जीर्णे जीर्णे, which seems to be incorrect. B reads जीर्णो जीर्णो.

(6) हेमद्वति(?)संनिभो भवेत् सूतः, a variant in A.

(7) कनकच रसतालयुतं, a variant in A, which is a defective metre. The reading of B, which we have adopted, is also a defective metre. The word चैत् or स्यात् should be added after the word युतम्.

[टोका—एतद्भस्मजीर्णसूतस्य लक्षणमाह—]

तच्चूर्णे सूतवरे त्रिगुणं जीर्णे द्वि^१ जीर्णे तु ।

द्रुतहेमनिभः सूतो^२ रज्यति लोहानि सर्वानि^३ ॥

[टोका—सर्वेषां धातूनां रसानामुत्तरोत्तरविशेषत्व-
माह—]

पत्रादष्टगुणं सत्त्वं सत्त्वादष्टगुणं द्रुतिः ।

द्रुतेरष्टगुणं वीजं तस्माद्वीजं तु जारयेत् ॥

(1) A reads जीर्णे तु. B reads जीर्णे द्वि.

(2) द्रुतहेमनिभसूतो, a variant in A, which seems to be incorrect.

(3) A has रज्यति लोहानि सत्त्वानि. B has रज्यति लोहानि सर्वानि. Both the readings have defective metre.

(4) This verse is found in A after the verse तारक-
दरदन्त्रिणाभिः &c, (vide ante pp 28—29) and runs thus :—

पत्रादष्टगुणं दत्त्वा सत्त्वादष्टगुणं द्रुतिः ।

द्रुतेरष्टगुणं वीजं तस्माद्वीजं तु जारयेत् ॥

नवमः पटलः ।

[टीका—बीजप्रशंसनमाह—]

इति रक्तोपि रसेन्द्रो बीजेन विना न कर्मकदुभवति ।

द्विविधं तत् पीतसितं¹ नियुज्यते सिद्धये च रसम्² ॥

[टीका—रसोपरसधातूनां बहुविधत्वात् शोधन-
माह--]

तस्य विशुद्धिर्बहुधा³ गगनरसोपरसलोहचूर्णैश्च ।

द्विविधं बीजं तैरपि नाशुद्धैः शुध्यते कदाचिदपि⁴ ॥

[टीका—अशुद्धबीजप्रभावमाह—]

यः पुनरेतैः कुरुते कर्माशुद्धैर्भवेद्रसस्तस्य ।

(1) B reads पीतं सितं which destroys the metre.

(2) नियुज्ये सिद्धये च रसः, an incorrect variant in A. नियुज्यते सिद्धये च तत्, a variant in B. Both texts are collated in our adopted reading.

(3) रसति शुद्धिर्वाचा, a variant in A, wherein the first term seems to be incorrect.

(4) B reads नैतत् instead of कदाचिदपि. This is incorrect ; since it contains two negatives.

अव्यापकः पतङ्गो¹ न रसे न रसायने योग्यः² ॥

[टीका—रससंज्ञकानाह—]

वैक्रान्तकान्त³संज्ञकमाक्षिक⁴विमलाद्रिदरद-

रसकाश्च⁵ ।

अष्टौ रसास्तथेषां सत्त्वानि⁶ रसायनानि च्युः ॥

[टीका—उपरससंज्ञकानाह—]

गन्धकगैरिकसुशिला⁷क्षितिखेचरमञ्जनश्च

कङ्कष्ठम् ।

उपरससंज्ञमिदं⁸स्वात् शिखिशिखिनौ सारलोद्भास्यौ ॥

(1) अव्यापकपतंगि, a variant in A, which is incorrect.

(2) A reads योग्ये. B reads रसायनयने योग्यः. Both the readings are incorrect.

(3) A omits कान्त,

(4) A reads माक्षिक, which mars the metre.

(5) A reads दलदरसकैश्च.

(6) A reads चत्वारि, which is not accurate.

(7) B reads शिखालक, which destroys the metre.

(8) B reads संज्ञकमिदं, which mars the metre.

[टीका—पूतिसंज्ञके आह—]

ताम्बारतोष्णशान्ताभ्रवज्रलोहानि¹ नागवह्नौ च² ।
कथितौ च पूतिसंज्ञौ³ तेषां संशोधनं कार्यम् ॥

[टीका—लवणक्षारसंज्ञे आह—]

सौवर्चलसेन्धवकां चूलिकसामुद्ररोमकविडानि ।
षड्लवणान्येतानि तु सर्जयिवटक्षणाः क्षाराः ॥⁴

[टीका—शोधकद्रावकगणमाह—]

सूर्यावर्तः⁵ कदली कन्या⁶ कोशातकी च सुरदाली ।
शौग्रश्च⁷ वज्रकन्दो नीरकणा काचमाची च ॥
आसामेकरसेन तु लवणक्षारान्नाशिता बहुयः ।
शुद्ध्यन्ति रसोपरसा धाता मुच्यन्ति सत्त्वानि ॥⁸

(1) B reads सत्वलोहानि.

(2) B reads बह्मनागौ च.

(3) B reads कथितौ कुभूतसंज्ञौ, which is incorrect.

(4) This verse is not found in A.

(5) A reads सूर्यावर्तक.

(6) B reads बन्धा.

(7) A reads श्रियुश्च.

(8) This verse is found in A only.

[टीका—शोधकद्रावकाणां शोधनद्रावणविधान-
माह—]

स्निग्धं सक्षारान्त्रैः¹ धातं वैक्रान्तकं हठाद्भवति² ।
तद् द्रुतमात्रं³ शुध्यति कान्तं शशरक्तभावनया ॥

[टीका—तच्चाह—]

सस्यकमपि रक्तगणैः⁴ सुभावितं स्नेहरागसंयुक्तम्⁵ ।
शुध्यति वारैः⁶ सप्तभिरतः परं युज्यते कार्ये⁷ ॥

[टीका—तच्चाह—]

क्षारैः स्नेहैरादौ पश्चादास्त्रेन⁸ भावितं विमलम् ।

(1) A reads सक्षारास्त्रे.

(2) A reads हठाद्भवति, which is incorrect.

(3) A reads तद्द्रुतमात्रे, which is incorrect.

(4) B reads रसगणैः, which seems to be incorrect.

(5) भावनतः स्नेहरागसंसिक्तं, a variant in A.

(6) A reads रागैः.

(7) सप्तभिरतः परं योजयेत् कार्ये, a variant in A, which mars the metre. B reads सप्तभिरभितः परं, wherein अभितः is incorrect as well as a defective metre.

(8) B reads पश्चात् उत्प्रेषणे.

शुध्यति तथा च रसकं दरदं माक्षीकमप्येवम्' ॥

[टीका—तान्त्रशोधनमाह—]

तनुरविपत्रं लिप्तं² लवणक्षारास्तरविस्त्रक्क्षीरैः³ ।

ध्मातं निर्गुण्डीरससिक्तं बहुशो वहेद्द्रवत्वञ्च⁴ ॥

[टीका—लोहशोधनमाह—]

शुद्धयति नागो वङ्गो घोषो रविणा च वारमुनिसंख्यैः⁵ ।

निर्गुण्डीरससैकैः⁶ स्तम्भूलरजःप्रवापैश्च ॥

[टीका—तच्चाह—]

(1) दरदमाक्षिकमप्येवं तथा शुद्धान्ति, a variant in A, where-
in the last two words are superfluous and incorrect.

(2) B reads तनुरपि पत्रलिप्तं, which has no sense.

(3) A reads क्षुद्धि. B reads क्षुद्धा. Both the readings
destroy the metre.

(4) A reads बहुशो वहेद्द्रक्तं. B reads बहुशो द्रवत्वञ्च.
Both the readings are defective.

(5) घोषी रविरौधमपि च मुनिसंख्यैः, a variant in A. B
reads रविणा च वारमुनिभिः. Both the readings are in-
correct.

(6) B reads सिकै, which is not correct.

रक्तगण्डगलितपञ्चलभाविपुटितं च रज्यते¹ तीक्ष्णम् ।

शुद्धति कदलीशिखिरसभाविपुटितं² त्रिभिर्वायैः ॥

[टीका—मारणमाह —]

सर्व्वः शुद्धति लोहो रज्यति³ सुरगोपसन्निभो वापात् ।

मासिकसत्त्वे भृङ्गं⁴ शुक्लं वा गन्धकेन हतम्⁵ ॥

एकादशः पटलः ।

छागास्त्रिभस्मनिर्मितमूषां कृत्वैवामलकाकारां ।

दलयोगे घनरन्ध्रां टंकणविषगुञ्जकतलेपां ॥

(1) A reads रज्यते, which is incorrect.

(2) शुद्धति कदलीशिखिरसभाविपुटितं, an incorrect variant in B.

(3) A and B read रज्यति, which is grammatically incorrect.

(4) A reads सङ्घट्ट. B reads दूरदृष्टम्. Both are unintelligible.

(5) A reads शुक्लेन वा गन्धकेन हतम्. B reads हतम्.

[टोका—अथ अन्यकारयितुर्वंशवर्णनमाह—]
 शीतांशुवंशसम्भवहैहयकुलजन्मजनितकुल¹महिमा ।
 जयति श्रीमदनरथः² किरातनाथो रसाचार्यः ॥
 [टोका—अथ चास्य कारयितुर्गुणवर्णनमाह—]
 यस्य स्वयमवतीर्णा रसविद्या सकलमङ्गलाधारा³ ।
 परमश्रेयसहेतुः श्रेयसि परमेष्ठिनः पूर्व्वम्⁴ ॥
 येन चतुर्वर्णस्त्रैष्ट्यादिव्याधादिलब्धसत्त्वाभम्⁵ ।
 दक्षिणरसा गृहीता⁶ आदिवराहेणेव महाप्रलये ॥⁷

(1) कुल is not found in B.

(2) स जयति श्रीमदनरथ, a variant in B.

(3) C reads सकलमङ्गलाधारा.

(4) Of the latter half C has only परं सहेतुः.

(5) C reads चतुर्वर्णस्त्रैष्ट्यादिव्याधातवध्वसत्त्वाभम्, which seems to be incorrect. Cf. Patala I., in which the following verse is given :—किरातगोपादिकतापसाद्यवनेचरासत्कुलसालधान्ये । विदन्ति नामाविषभेषजानां प्रमाद्यवर्णाकृतिनामजातीः ॥

(6) दक्षिणरस गृहीता is the incorrect reading in C. [In the case of किरातनाथ रसाः गृहीताः i. e. collected रस—mercury, minerals &c. and दक्षिण is favorable, and in the case of आदिवराह रसा गृहीता i. e. lifted up the earth.]

(7) This verse and the next are not found in B.

नष्टशरीरविवर्णा ह्रीनाङ्गाः कुष्ठिनो गुचादयस्य ।

अभिनवसोमेच्छरतामापुरपि पुनर्नवेरङ्गैः ॥

[टीका—कर्त्ता स्वनाममहत्त्वं सूचयन्नाह—]

तस्मात् किरातनृपतेः बहुमानमवाप्य रससुकर्म्मरतः¹ ।

रसहृदयाख्यं तन्म² विरचितवान् भिष्णुगोविन्दः³ ॥

नम्रा मङ्गलविष्णोः सुमनोविष्णोः सुतेन तन्मोयम्⁴ ।

श्रीगोविन्देन कृतः⁵ तथागतः श्रेयसे भूयात् ॥⁶

अष्टादशसंस्कारं रसेन्द्रदेवस्य दिव्यतनु दृष्ट्वा ।

लिखितमिदं पुण्यतमं रसहृदयमवाप्यते सकलम् ॥

(1) C reads रसकर्मोपदेशतो दृष्ट्वा, which destroys the metre.

(2) C reads रसहृदयेकतमं, which seems to be incorrect.

(3) C reads विरचितार्था भगवद्गोविन्दः, which is incorrect.

(4) C has रसाटव्यनाम तन्मोयम्, which is incorrect.

(5) C has श्रीमद्भगवद्गोविन्देन कृतं, which mars the metre.

(6) This verse and the next are not found in B.

इति श्रीमद्भगवद्गोविन्दविरचितं

रसहृदयं समाप्तम् ।¹

शुभसस्तु ।

संवत् १६०४ समये ज्यैष्ठ्ये वदि १३ भौमे

जगन्नाथभट्ट लेखि ॥

श्रीराम चाल संवत् १८८० पौष वदि ३ भौमे ।

(1) MS. A ends abruptly with the colophon, which runs thus :—इति श्रीगोविन्दभगवत्पादविरचिते रसहृदये गौर्धरस-
क्रियाधिकार एकविंशतितमः पटलः ॥ The author's account
of himself is altogether wanting in it. B has "इति सकल-
रसबैद्यकुलकिरीटभूषायमाचार्यपादपद्मरागसकलविद्यापारोष श्रीमद्भग-
वोविन्दकृतो रसहृदयः समाप्तः । इति श्रीमत्कुरलवंशपयोधिभुषाक-
निर्यमज्ञेयात्मजश्रीचतुर्भुजविरचितायां खण्डे बाला-
न्ययबोधिकाख्यायां रसहृदयटीकायां रसप्रज्ञासात्मक एकीनविंशोऽवबोधः ।
इति श्रीः" ॥

Extracts from KAKACHANDESVARIMATA.

काकचण्डेश्वरीमततन्वात्

समुद्धृताः श्लोकाः ।

ॐ नमः सदाशिवाय ।

कैलासशिखरासीनमुमा रुद्रं जगद्गुरुम् ।
क्रन्दनंदीमहाकाली भृंगचण्डीविनायकौ ॥ १ ॥
योगिनीनामष्ट तत्र गुह्याद्गुह्यतरं परम् ।
कपाली कालरात्री च कालचंद्रकलाम्बिका^१ ॥ २ ॥
कराली कालकर्णी च काकचण्डेश्वरी तथा ।
एवमादिस्तथा चान्या योगिनौगणगुह्यकैः^२ ॥ ३ ॥

(1) The text reads कालचंद्रकलाम्बिका, which is incorrect.

(2) The text reads गुह्यकौ, which is incorrect.

नृत्यवाद्यसुखेशानैः सानन्दैर्हृष्टचेतसैः ।
 तत्रस्थं भैरवं देवं योगिनीगणवेष्टितम् ॥ ४ ॥
 केचित् स्तुवन्ति संहृष्टाः केचिद्विनायन्ति गुह्यकाः ।
 केचिन्नृत्यन्ति गुह्या ये केचिदवाद्यं न कुर्वते ॥ ५ ॥
 हृषितं^१ भैरवं देवं पञ्चवक्त्रं त्रिलोचनम् ।
 तं दृष्ट्वा भैरवी हृष्टा जगतां त्रिदशेश्वरी ॥ ६ ॥
 कृताञ्जलिपुटा भूत्वा कृष्णतारकलोचना ।
 काकचण्डेश्वरी देवी उवाचेदं तु भैरवी ॥ ७ ॥

काकचण्डेश्वरी उवाच ।

भगवन् देवदेवेश सर्वज्ञ सर्वविष्टिव^२ ।
 सर्वज्ञानप्रकाशाय अहं पृच्छामि शंकर ॥ ८ ॥
 कथं कायस्थितो जीवो जीवकोऽसौ प्रकीर्तितः ।
 कायस्थः कर्मणा केन स्थितः संसारपञ्जरे ॥ ९ ॥
 जराव्याधिदारिद्रेण ग्रस्तः संसारबन्धनैः ।
 एको ब्रजति यानेन एकः स्कन्धे वह्नेश्च तम् ॥ १० ॥

(1) The text reads दृष्टं, which is not correct.

(2) The text reads सर्वविष्टिवः, which is not correct.

जयजयशब्दं मांगल्यमेकस्थाने च जंतवः ।

किं कुर्वाणाः प्रकुर्वाणाः कस्मान्मे ब्रूहि मंकर ॥ ११ ॥

श्रीसर्वज्ञ उवाच ।

शृणु त्वं काकचामुंडे साधकानां हितं प्रिये ।

गुह्याद्गुह्यतरं वाक्यं पृष्टोऽहं तु वरानने ॥ १२ ॥

कथयामि समासेन शृणु त्वं काकचंडिके ।

यस्यार्थश्च परो नित्यः अनादिनिधनेश्वरः ॥ १३ ॥

सुरूपो निर्गुणः शांतो विश्वव्यापी परात्परः ।

अनादिकर्मसंबन्धः कायस्थो भवते तु सः ॥ १४ ॥

जीवे व्याधिभयं कर्म अज्ञानात् संप्रकीर्तितम् ।

तस्मात् कर्मभवात् क्लिष्टः संसारे संसरेत्तु सः ॥ १५ ॥

करोति^१ विविधं कर्म संसारे काममोहितः ।

द्रव्योपायं न जानाति कामभोगार्थहेतुना ॥ १६ ॥

काय^२क्लेशेन मानव्यो द्रव्योपायं करोति सः ।

कृषिवाणिज्यसेवायां मेधाविक्रयविक्रये ॥ १७ ॥

(1) The text reads काकचंते, which is incorrect.

(2) The text reads करोतु, which is not accurate.

(3) The text reads कालक्लेशेन, which is not correct.

वहन्ति काष्ठभारांश्च दृणभारमनेकधा ।
 यानं यवनच्छत्रं¹ च किं करोति² करोति सः ॥१८॥
 कामासक्तनरः श्रीमान् कुरुते कर्म नैकधा³ ।
 कुर्वाणश्च नराः केचित् कामासक्तार्थचिन्तकाः ॥१९॥
 जायन्ते मर्त्यलोकेस्मिन् दारिद्र्योपहतचेतसः ।
 जायन्ते नात्र संदेहो कुञ्जखंजा नपुंसकाः ॥ २० ॥
 महासंसारबन्धेन त्रिगुणेन सुयन्त्रिताः ।
 अटव्यां घोरसंघट्टघाटिकां तु नयन्ति तत् ॥ २१ ॥
 एतन्ने कथितं भद्रे यत्त्वं मां परिपृच्छसि ।
 किमन्यत् पृच्छसे भद्रे तथा ते कथयाम्यहम् ॥ २२ ॥
 इति काकचण्डेश्वरीमते प्रथमः पटलः ।

श्रीकाकचण्डी उवाच ।

कथयस्व महादेव कामभोगप्रसाधनः ।
 अर्थः संपद्यते येन अक्लेशात् परमेश्वर ॥ १ ॥

- (1) The text reads यवनच्छत्रं, which is incorrect.
- (2) The text reads किं कुर्वेति, which is incorrect.
- (3) The text reads कुरु कर्ममनेकधा, which is incorrect.

तदहं श्रोतुमिच्छामि कथयस्व प्रसादतः ।
 आकाशगमनं देव खेचरत्वं यथा भवेत् ॥ २ ॥
 पादुकाया दले पंचदिव्यस्त्रीकामसाधनम् ।
 रोचनं अञ्जनं चैव धातुवादरसायनम् ॥ ३ ॥
 जलूकाबंधमित्याहुः रसस्य मारणं कथम् ।
 जारणं रत्नकर्तृत्वं वज्रभद्रावणं कथम् ॥ ४ ॥
 एतत् सर्वं समासेन ब्रूहि मे त्रिपुरांतक ।

श्रीभैरव उवाच ।

शृणु त्वं काकचारुंडे साधकानां हितं प्रिये ॥ ५ ॥
 कथयामि समासेन पृथक् सिद्ध्यर्थसाधनम् ।
 न द्रव्येण विना सिद्धिर्न भोगाः काम एव च ॥ ६ ॥
 द्रव्यहीना नरा मर्त्ये प्रेतरूपेण संस्थिताः ।
 अटन्ति मर्त्यलोकेऽस्मिन् पर्युपद्रवकारणम् ॥ ७ ॥
 * * * विवं (?) तेषां जायतोपि मृतश्रुतेः ।
 कुलं सौभाग्यरूपं च पाण्डित्यं ज्ञानसंस्थितम् ॥ ८ ॥
 द्रव्यहीना न शोभन्ति प्राणहीना नरा यथा ।
 कुम्भितो घ्राणहीनोपि केनापि वधिराः स्थिताः ॥ ९ ॥

पद्यन्ते मर्त्यलोकेऽस्मिन् द्रव्यस्थं मकरध्वजम् ।
 तस्मात् संसाधयेद्देवि रसेन्द्रं साधकोत्तमः ॥ १० ॥
 अथातः संप्रवक्ष्यामि रसेन्द्रसाधनं तव ।
 मारणं जारणाद्यं च द्रव्यसाधनमुत्तमम् ॥ ११ ॥
 वज्रदंडः सुदंडश्च लोहदंडस्तथैव च ।
 त्रयो विना ओषधये रसस्य मारणे हिताः ॥ १२ ॥
 तान्निबोध समासेन यथा जानन्ति साधकाः ।
 वज्रदंडस्तु वज्री स्यात् लोहदंडं पुटं विडः ॥ १३ ॥
 सुदंडं ब्रह्मदंडं च समासात् कीर्तितं तव ।
 ग्राहयेत्तं समासेन साधकां हृष्टमानसः ॥ १४ ॥
 तद्रसं रससंयुक्तं एकीकृत्य तु मर्दयेत् ।
 अंधमूषागतं धातं रसं म्रियेत तत्क्षणात् ॥ १५ ॥
 सहस्रवेधी कर्त्ता च ज्ञायते स महारसः ।
 मूषां संलेपयेत् तेन पुरागृह्य महौषधीः ॥ १६ ॥
 अंधयित्वाग्निमध्ये तु रतिबंधः अयं विधिः ।
 पश्चात् पलसहस्रैकं शुल्बस्य ग्राहयेद्बुधः ॥ १७ ॥
 अश्ववर्गहृतं शुल्बं क्षारवर्गहृतं शुभम् ।
 वज्रीक्षीरार्कक्षीरेण मर्दयेत् शतधा नरः ॥ १८ ॥

पुटं दद्यात् समासेन कालिकारहितं भवेत् ।
 मूषागर्भोदरे क्षिप्वा धामयेत् खदिरानलैः ॥ १८ ॥
 रसेन्द्रः क्षिप्यते तत्र तारं संजायते क्षणात् ।
 अथातः संप्रवक्ष्यामि मूषाबन्धं यथा भवेत् ॥ २० ॥
 मृत्तिकाः ग्राहयेत् प्राञ्जस्तृणपाषाणवर्जिताः ।
 तुषादग्धास्त्रयो ग्राह्या मृदुभागास्तु चयस्तथा ॥ २१ ॥
 एकोक्तस्य तु संबंधे मूषां तत् कारयेदुबुधः ।
 गोस्तनाकारसदृशौमथवामलकं कुरु ॥ २२ ॥
 मूषाबन्धमिति ख्यातं साधकानां हिताय वै ।
 अथान्यत् संप्रवक्ष्यामि रसस्य मारणं यथा ॥ २३ ॥
 ग्राहयेत् पूर्ववदुभूयः ओषधीस्त्रिस्तः साधकः ।
 मूषां संलेपयेत् तेन धाम्य कर्म समाचरेत् ॥ २४ ॥
 रसेन्द्रो म्रियते क्षिप्रं कुरु कर्म यदिच्छया ।
 वीतोदकेन कामेन हेमकर्माणि वा शृणु ॥ २५ ॥
 कारयेत्कोहमयं पात्रं तस्योर्ध्वं मृन्मयं शुभे ।
 अग्न्योऽग्न्यपृष्ठरुलम्बं कारयेत् साधकोत्तमः ॥ २६ ॥
 अधोयन्त्रेण तं धाम्य आयसं तत्र जारयेत् ।
 तप्तप्लव्णोदरे घृष्टं जरते नात्र संशयः ॥ २७ ॥

तद्गुणं आयसं तच्च हेमं चाष्टगुणं ददेत् ।
 क्षीरवज्रं तथा चारौ षट्जारी उदिरपट्टौ । (?)
 आह्वयित्वा रसं तेषां आयसं जारयेन्नरः ॥ २८ ॥
 हेमं संजायते तच्च धर्म्मकामार्थसाधनं ।
 गृह्य खल्वोदरे तस्मै हेमं षड्गुणतां भजेत् ॥ २९ ॥
 पुरा महीषधैर्युक्तं जरते नात्र संशयः ।
 जारिते सारितं दद्यात् पुनस्तं जारयेद्यदि ॥ ३० ॥
 कुरुते कर्मसंघास्य कर्म सिद्ध्यर्थसाधनं ॥ ३१ ॥
 जारणं मारणं चैव समासात् कौर्त्तितं मया ।
 किमन्यत् पृच्छसे भद्रे तथा ते कथयाम्यहम् ॥ ३२ ॥
 इति श्रीकाकचण्डेश्वरीमते द्वितीयः पटलः ।
 अथान्यं संप्रवक्ष्यामि अन्नकस्य यथाक्रमम् ॥ २० ॥
 द्रावणं अन्नकस्येव समासेन विधीयते ।
 क्षीरकंचुकिचूर्णेन तद्रसेनाभिभाषितं ॥ २१ ॥
 निर्गुणक्षीरवज्रदण्डं तु तद्रसे भाषितं कुरु ।
 एकैकं सप्तवारैस्तु भावयेत् साधकोत्तमः ॥ २२ ॥
 (भावनान्ते) अन्नकस्य अन्ने क्षिपेद्दिनत्रयं ।
 ब्रह्मत्या सप्तरात्रं तु क्षिपेदन्नं नरोत्तमः ॥ २३ ॥

तेन कल्केन पत्राणि लेपयेदभ्रकस्य च ।
 कांस्यपात्रेण * * * स्तारं साधकोत्तमः ॥ २४ ॥
 सूर्यधान्नि ततो धाप्यः सप्ताहं साधकोत्तमः ।
 द्रवते नात्र संदेहः प्रियं दृष्ट्वा यथा स्त्रियः ॥ २५ ॥
 रसस्य भागमेकं तु द्रुतभागसमं कुरु ।
 एकोक्त्य तु तद्दाम्यं म्रियते नात्र संशयः ॥ २६ ॥
 लक्षांशवेधकोऽसौ हि जायते नात्र संशयः ।
 अथान्यं संप्रवक्ष्यामि यथा संजायते द्रुतिः ॥ २७ ॥
 ग्राहयेदभ्रकं प्राज्ञः पौतं वा कृष्णमेव वा ।
 पुरा संस्कारयुक्तं तु कर्त्तव्यं साधकेन तु ॥ २८ ॥
 यवासा चित्रकं धारः कंचुकीवज्रदंडयोः ।
 वज्रकंदार्कशीरं च भस्मात् टंकणं तथा ॥ २९ ॥
 क्षारत्रयममायुक्तं पटपंचसमन्वितं ।
 एकोक्त्य तु कल्केन अभ्रपत्राणि लेपयेत् ॥ ३० ॥
 मूषागर्भोदरे क्षिप्त्वा धामयेत् खादरानलैः ।
 द्रवते नात्र संदेहो * * * * *
 इति काकचंडेश्वरीमते षष्ठः पटलः ।

Extracts from RASENDRACHUDAMANI.

सोमदेवविरचितात् रसेन्द्रचूडामणः

उद्धृताः श्लोकाः ।

रूप्येण सह संयुक्तं धातं रूप्येण चेत्तगीत्^१ ।
तदा निरुत्यमित्युक्तं लोहं तदपुनर्भवम् ॥
एवं रूप्यं सनागं चेत् धातं ताम्रे लगेन्नहि ॥

निष्कमात्रे तु नागेऽस्मिन् लोहखार्थ्यां हृते सति ।
स्वतो लक्षगुणां हैमीं शलाकां यसति ध्रुवम् ॥
कुसुमैलतप्तं तत् स्वर्णमुद्गिरति^२ ध्रुवम् ।
गुह्यनागोऽयमुद्दिष्टो वर्त्ति^३ स्वच्छन्दभैरवः ॥

(1) The text reads लघु. But रसरवसमुच्चय reads लगीत्,
which seems to be correct.

(2) The text reads स्वर्णे मुद्गिरि, which is incorrect.

(3) The text reads मुद्गिरवर्त्ति, which has no sense.

तीक्ष्णं नीलाञ्जनोपेतं धातं हि बहुशो दृढम् ।
 मृदुक्लृणं द्रुतद्राव¹ वरनागं तदुच्यते ॥
 मृतस्य पुनरुद्भूतिः संप्रोक्तोत्थापनाख्यया² ।
 द्रुतद्रव्यस्य निक्षेपो द्रवे तद्भालनं मतम् ॥
 त्रिंशत्पलमितं नागं भानुदुग्धेन मर्दितम् ।
 विमर्दं पुटयेत्तावत् यावत् कर्षाविशेषितम् ॥
 न तत् पुटसहस्रेण क्षयमायाति सर्व्वथा³ ।
 चपलोऽयं समुद्दिष्टो वार्त्तिकैर्नागसम्भवः⁴ ॥
 इत्थं हि चपलः⁵ कार्य्यी वङ्गस्यापि न संशयः ।
 तत्सृष्टहस्तसंसृष्टः केवली बध्यते रसः ॥

(1) The text has द्रुतद्रावौ, which is incorrect. We have adopted the text of रसरत्नसमुच्चय.

(2) The text reads साधोक्तस्थापनाख्यया, which seems to be erroneous.

(3) The text has क्षयमायाति सर्व्वदा, which is grammatically incorrect.

(4) The text reads मार्गसंभवः, which is incorrect.

(5) The text reads इत्थं चौरपलः, which is senseless.

स रसो धातुवादिषु शस्यते न रसायने¹ ।
 अयं हि खर्वणाख्येन² लोकनाथेन कीर्तितः ॥
 भ्रामकाख्यरजः सूक्ष्मं पञ्चमांशरसान्वितम् ।
 कुमारौमूलतोयेन मर्द्दयेदेकवासरम् ॥
 चाङ्गेरीखरसेनापि दिनमेकमनारतम्³ ।
 एवं भूनागधातेन मर्द्दयेद्विसहस्रम् ॥
 अथैकपलमानेन तावता त्रपुष्पापि च ।
 दशनिष्करसेन्द्रेण श्लक्ष्णपिष्टीं समाचरेत् ॥
 योजयित्वाथ कल्केन यथापूर्व्यं विमर्द्दयेत् ।
 ततः साररसेन्द्रेण सत्त्वेन रसकस्य च ।
 पिष्टीं कृत्वा तु पूर्व्येण पूर्व्वकल्केन योजयेत् ॥
 अथ प्रक्षाल्य कोणो⁴ काष्ठीकेन प्रशोषयेत् ।

(1) The text has रसायनम्.

(2) खर्वणाख्येन is the reading in रसरत्नसमुच्चय.

(3) The text reads दिनमेकमनारसम्, which has no clear sense.

(4) The text reads सौहेन, which is unintelligible.

पलाङ्गशुद्धसस्येन भृष्टगुल्फारसेन च ।
 विमर्दय काष्ठीके कुर्यात् मरिचप्रमितां गुटीम्¹ ॥
 निरुध्य वज्रमूषायां सन्धिवन्धं विधाय च ।
 शुषिरैर्नवभिः² सम्यग्भस्त्राभ्यां च धमेत् खलु ॥
 ततो मूषागतं सत्त्वं समादाय समन्ततः ।
 धमेत् प्रकटमूषायां वङ्कनासेन शुद्धये ॥
 दशशणं हि तत्सत्त्वं भस्त्रना लवणेन च ।
 सकाष्ठीकेन संवेष्ट्य पुटयोगेन शोधयेत् ॥
 द्विनिष्कप्रमिते तस्मिन् पूर्वप्रोक्तेन भस्त्रना ।
 अशीतिगुणितं नागं धात्वा निर्वाहयेत् खलु ॥
 इयता³ पूर्वसूतोऽसौ जीयते न कथञ्चन ।
 चपलोऽयं समुद्दिष्टो लोकनाथेन शम्भुना ॥
 अनेनापि रसः शीघ्रं बध्यते पूर्ववत् खलु ।
 कारवल्लीजटाक्षुरैर्दशधा पुटितो हि सः ।
 भवेन्नागविनिर्गन्तो यासं गृह्णात्यशेषतः ॥

- (1) The text reads मरिचप्रमिता गुटी, which is incorrect.
- (2) The text reads शुषिरैर्नवभिः, which has no sense.
- (3) The text reads इयता, which is incorrect.

मुखं प्रकटमूषायां भवेच्च विगुणोत्तरम्¹ ।
 जीर्णं प्रासो रसोऽप्येष देहलोहकरो भवेत् ॥
 सोऽयं श्रीसोमदेवेन कथितोऽतीव निश्चितम् ॥
 भूभुजङ्गशक्तत्तयेः² प्रस्ताव्यापद्धतं³ रजः ।
 कृष्णवर्णं हि तत् प्रोक्तं धीतास्व⁴ रसवादिभिः ॥

स्वरूपस्य विनाशेन पिष्टतापादनं हि यत् ।
 विद्मद्भिर्वर्जितः⁵ सूतो नष्टपिष्टः स उच्यते ॥
 अथ यन्त्राणि वक्ष्यन्ते रसतन्त्राण्यनेकशः⁶ ।
 समालोक्ष्य समासेन सोमदेवेन सांप्रतम् ॥

- (1) The text reads विगुणोत्तरा, which is inco. rect.
- (2) The text reads ताये, which is not accurate.
- (3) The text has अपद्धतं which is not accurate.
- (4) The text reads धीतास्व, which is not correct.
- (5) But रसरसमुच्चय reads विद्मद्भिर्वर्जितः.
- (6) But रसरसमुच्चय reads अनेकशः.

ऊर्ध्वपातनयन्त्रं हि नन्दिना परिकीर्तितम् ॥

कोष्ठि(ष्टि)कायन्त्रमेतद्धि नन्दिना परिकीर्तितम् ॥

विन्ध्याद्रौ हिमपर्व्वते च मलये गोमन्तके श्रीगिरौ
सद्म्याद्रावथ पारियात्रकगिरौ किंकिंधिनामालये ।
माहेन्द्रेऽप्यथ चाल्पवत्क्षितिधरे तद्रूपनामाधिकं
गोपाभीरकसिद्धवेद्यमुखतो वेद्यः समावेद्यताम् ॥

इति श्रीकरवालभैरवपुरवरपतिश्रीसोमदेवविरचिते
रसेन्द्रचूडामणौ रससूत्रस्थाने रसमहिम-
निरूपणं नाम प्रथमोऽध्यायः
समाप्तः ।

Extracts from RASAPRAKASASUDHAKARA.

यशोधरविरचितात् रसप्रकाशसुधाकरात्

उद्धृताः श्लोकाः ।

विमलसूतवरो हि पलाष्टकं
तदनु धातुघटीपटकाक्षिकाः ।
पृथगिमास्य चतुःपलभागिकाः
स्फटिकशुद्धपलाष्टसमन्विताः ।
महजलेन विमर्द्य च यामकं
लवणकान्मजलेन विमिश्रितम् ।
उदितधातुगणस्य च मूषिकां
कुरु रसं विनिवेशय तत्र व ।
उमरूकाभिधयन्मवरेण तं
हिदशयाममजाचयवह्निना ।
पवनपित्तकफक्षयकारकं
सकलरोगहरं परमं सदा ।

गजपतेर्बलवद्वलदो नृणां
 द्विजपतीक्ष्णवन्नयनप्रदः ।
 युवतिकामविलासविधायको
 भवति सूतवरः सुखदः सदा ।
 सघनसाररसः किल कान्तिद-
 स्वखिलकुष्ठहरः कथितो मया ॥

इति कर्पूररसः ॥

उदयभास्करनामरसो ह्ययं
 भवति रोगविधान्तकरः स्वयम् ।
 मगधिकामधुना सह गुञ्जिका-
 द्रव्यमितस्य सदा परिसेवितः ।
 ललितकामविलासविधायकः
 स्थविरकोऽपि रतौ तरुणायते ॥
 गदहरो बलदोऽपि हि वर्णदो
 भवति कर्णविपाकजरोगहा ।
 सकलसूतकशास्त्रविमन्त्रजो
 द्विजवरेण मया प्रकटीकृतः ॥

इति उदयभास्कररसः ॥

अयेदानीं प्रवक्ष्यामि धातुशोधनमारणम् ।
 अनुभूतं मया किञ्चित् किञ्चिच्छास्त्रानुसारतः ॥
 सुवर्णं रजतं चेति लोहं शुद्धमुदीरयेत् ।
 ताम्रं चैवाश्लसाराश्च नागवङ्गौ तथैव च ॥
 तीक्ष्णलोहं निगदितं द्वितयं रसवेदिभिः ।
 समिश्रलोहचितयं सौराष्ट्ररीतिवर्त्तकाः ।
 एतेऽष्टौ धातवो ज्ञेया लोहान्येवं भवन्ति हि ॥

अथ रसकगुणाः ।

द्विविधो रसकः प्रोक्तः कारवेत्तक-दुर्दरः¹ ।
 सत्त्वपाते परः प्रोक्तः प्रबलबोधधादिषु ॥
 स तु² मेहहरच्चैव पित्तश्लेष्मविनाशनः ।
 रञ्जनः पारदस्त्राय नेत्ररोमक्षयापहः³ ॥

(1) The text reads कानो बलवदुर्दरः, which appears to be incorrect.

(2) The text reads सत्त्व, which seems to be incorrect.

(3) The second hemistich is wanting in the text.

We have adopted the reading of रसरत्नसमुच्चय.

पारदो रसकश्चैव देहलोहकारावभौ ।
 नागाङ्गुनेन कथितौ सिद्धौ श्रेष्ठौ रसावभौ ॥
 कृतौ येनाग्निसहनौ मृतखर्परकौ शुभौ ।
 तेन स्वर्णमयी सिद्धिरर्जिता¹ च न संशयः ॥
 रसको द्रावितः सम्यक् निश्चितो रसपूरके ।
 निर्मलत्वमवाप्नोति सप्तवारं निमज्जितः² ॥
 काञ्चिके वाथ तक्ने वा नृमूत्रे³ मेषमूत्रके ।
 द्रावितं क्षालितं⁴ सम्यक् खर्परं परिशुध्यति ।
 खर्परं रेचितं शुद्धं स्थापितं नरमूत्रके ।
 रज्जयेन्नासमेकं हि ताम्रं स्वर्णप्रभं वरम् ॥

(1) The text reads सिद्धौ राजिता, which is not accurate.

(2) The text reads निमज्जितं, which is incorrect.

(3) The text has only मूत्रे, which mars the metre.

(4) द्रावितं क्षालितं is the reading of the text, which is evidently an error.

वचाहरिद्रात्रिफला-गृहधूमैः ससैन्धवैः ।
 भक्षातकैष्टङ्गणैश्च क्षारैराम्लैश्च महितम्¹ ॥
 पादांशसंयुतैर्मूषां हन्ताकफलसन्निभाम् ।
 निरुध्य शोषयित्वा च मूषामुखोपरि न्यसेत् ॥
 प्रधाते खपरे खाला सिता नीला भवेद्यदि ।
 लोहसंदंशके मूषां घृत्वा कृत्वा ह्यधोमुखीम् ॥
 भूम्यामाढालयेत् सत्त्वं यथानालं न भज्यते ।
 तदा सीसोपमं² सत्त्वं पतत्येव न संशयः ॥
 अनेनैव प्रकारेण वारत्रयकृते सति ।
 विनिःसरेत् सर्व्वसत्त्वं सद्भिर्गु(?)गुरुणोदितम् ॥
 अथ सौराष्ट्रौगुणाः ।
 सौराष्ट्रदेशे सञ्जाता खनिजा³ तुवरी मता ।
 या लेपिता श्वेतवस्त्रे रङ्गबन्धकरी हि सा ॥

(1) The text reads वर्जितं, which seems to be incorrect.

(2) रसरत्नसमुच्चय says वर्जितं. See Chap. II. Verse 161.]

(3) The text reads खनिता, which is incorrect.

फुल्लिका छटिका¹ तद्वत् द्विप्रकारा प्रशस्यते ।
 किञ्चित् पीता च सुस्निग्धा गरदोषविनाशिनी ॥
 श्वेतवर्णा परा साक्षा फुल्लिका लोहमारणी ।
 कषाया मधुरा काङ्क्षी कटुका विषनाशिनी ।
 व्रणघ्नी कफहा चैव नेत्रव्यापन्निदोषहा ॥
 कण्ठरोगहरा सा तु पारदे वोज्ज्वारणी ।
 धान्यान्ने तुवरी क्षिप्ता शुध्यति चिदिमेन वै ॥
 क्षारेरास्त्रैश्च मृदिता भ्राता सत्त्वं विमुञ्चति ।
 तत् सत्त्वं धातुवादार्यं क्षौषधे नोपपद्यते ॥

अथ पुटानि लिख्यन्ते ।

भूम्यां वै खन्यते गर्तं द्विहस्तं चतुरस्रकम् ।
 छगणेन सहस्रेण पूरयेत्तदनन्तरम् ॥
 क्षौषधं धारयेन्मध्ये तदाच्छाद्य वनोपलैः ।
 सहस्राह्णेन वै सम्यग्दङ्गिं प्रक्षालयेत्ततः ॥
 महापुटमिदं प्रोक्तं अन्यकारेण निर्मितम् ॥

इति महापुटम् ॥

(1) रसरत्नसमुच्चय 229B कटुकी फुल्लिका.

एकहस्तप्रमाणं हि चतुरस्रं च गर्त्तकम् ।
 वनोपलसहस्रेण गर्त्तमध्यं च पूरितम् ॥
 मूषिकां चौषधेनाथ पूरितां तां तु मुद्रयेत् ।
 गर्त्तमध्ये निधाय गरीष्ठानि¹ च निक्षिपेत् ॥
 ऊर्ध्वान्निं ज्वालयेत् सम्यक् सोऽयं गजपुटो भवेत् ॥
 इति गजपुटः ॥

उपलं पिष्टकं छाद्यमुत्पलस्य गरीष्ठकम् ।
 छगणोपलसारौ च तचरा² छगणाभिधाः ॥
 भरन्निमात्रे कुण्डे च वाराहपुटमुच्यते³ ॥
 इति वाराहपुटः ॥

वितस्त्रिद्वयमानेन गर्त्तं चैश्चतुरस्रकम्⁴
 कुक्कुटास्थं पुटं विद्यादौषधानाञ्च साधनम् ।
 इति कुक्कुटपुटः ॥

(1) रसरत्नसमुच्चय reads गरीष्ठानि.

(2) रसरत्नसमुच्चय reads वराटी.

(3) The text reads भरन्निमात्रेण कुण्डे च वाराहपुटमुच्यते,
 which seems to be incorrect.

(4) The text reads गर्त्तं कुक्कुटचतुरस्रकं, which mars the
 metre.

छगणैरष्टभिः सम्यक् कपोतपुटमुच्यते ।

इति कपोतपुटः ॥

तुषैर्वा गोवरैर्वापि रसभस्मप्रसाधनम् ।

माणिकाद्यमानेन गोवरं पुटमुच्यते ।

इति गोवरपुटः ॥

मृदभाण्डे तु प्रपूर्यैव मध्ये द्रव्यं तु विन्यसेत् ।

अधस्ताज्ज्वालयेदग्निं मृदभाण्डपुटमुच्यते ॥

इति (मृद)भाण्डपुटः ॥

गर्ते तु बालुकापूर्णे मध्ये द्रव्यं तु विन्यसेत् ।

उपरिष्ठादधस्ताच्च वज्रिं कुर्यात् प्रयत्नतः ।

तद्बालुकापुटं सम्यगुच्यते शास्त्रकोविदैः ॥

इति बालुकापुटः ॥

मूषिकां भूमिमध्ये तु स्थापितां द्रव्यकुलादधः ।

उपरिष्ठात् पुटं दद्यात्¹ तत् पुटं भूधराभिधम् ॥

इति भूधरापुटः ॥

(1) The text reads दद्यात्, which is incorrect.

गोचरैर्वा तुषैर्वापि माचाकर्षमितैः पुटम् ।

यत्र तन्नावकाख्यं स्वाप्नदृद्रव्यस्य साधने ॥

इति लावकापुटः ॥

इति श्रीपद्मनाभसूनुश्रीयशोधरविरचिते

रसप्रकाशसुधाकरे दशमोऽध्यायः ।

अथातः संप्रवक्ष्यामि धातूनां कौतुकं परम् ।

स्नानुभूतं मया किञ्चित् श्रुतं यच्छास्त्रतः खलु ।

तदहं कथयिष्यामि यत् कृत्वा ना सुखी भवेत् ॥

रसकं दरदं ताप्यं गगनं कुनटीसमम् ।

रक्तकुङ्कीपयोभिश्च मर्ह्येद्दिनसप्तकम् ॥

जलयन्त्रेण वै पाच्यं चतुर्विंशतियामकम् ।

तेन वेध्यं द्रुतं ताम्रं तारं वा नागमेव वा ॥

सह(शत)वेधौ तु तत्कल्को जायते नात्र संशयः ॥

एकभागस्तथा सूतो वज्रवज्राय मर्हितः ।

सहो त्रिभिर्गन्धाश्च रवे पञ्चभागसमन्विते ।

वेद्ययज्या च रागिण्या पीतकल्कं प्रजायते ॥

षोडशश्रेण दातव्यं कृते ताम्बे सुशोभने ।

जायते प्रवरं हेम शुद्धं वर्षचतुर्दशम् ।

इति हेमक्रिया ॥

स्वर्णमाक्षिकं संस्त्रोय काष्ठीके दिवसत्रयम् ।

चर्मरंग्या(गा)रसेनैव मर्दयेद्दिनसप्तकम् ।

जलेन धीतं तावच्च यावद्धेमनिर्भं भवेत् ।

दरदं रसदेशीयं¹ गोमूत्रेणैव स्वेदयेत् ।

दोलायन्तेऽङ्गि² चत्वारि पञ्चाङ्गुलतमो भवेत् ॥

मनःशिला पद्मनिभा रक्ता चैव सुशोभना ।

स्वेदिता मुनिपुष्पस्य रसेनैव तु दोलया ।

याममर्चमिता शुद्धा सर्वकार्येषु योजयेत् ॥

नवसारस्तथा सूतः शोधितोऽम्बिमति स्वसे ।

समभागानि सर्वाणि मर्दयेन्निम्बुकारसैः ॥

मातुलुङ्गरसेनैव कुमारीसुरसेन वा ।

सूर्यातपे विमर्दोऽसौ पाचितो जलयन्त्रके ।

दिनानि त्रीणि तीव्राग्नी कुर्व्यात्तदवतारयेत् ॥

(1) The text reads रसदेशीय, which is incorrect.

(2) चङ्गि [चत्वारि] is grammatically incorrect.

शतांशं वेधयेत्तारं शुद्धहेम प्रजायते ।
 जलभेदो यदा न स्यान्नात्र कार्या विचारणा ॥
 शिलया मारितं नागं कुमार्याः स्वरसेन तु ।
 पुटद्वादशयोगेन नागभस्म प्रजायते ॥
 शतसंख्यानि वै कुर्यात् पुटान्येवं शरावके ।
 कुमार्याः स्वरसेनैव भावयेद्द्विसप्तकम् ॥
 पूर्व्ववत् पुटनं कार्यं शतसंख्यामितं तथा ।
 सूतगन्धशिलादद्गुप्तं चेन्नागभस्मकम् ।
 त्रिंशदनोपलैर्दद्यात् पुटं वाराहसंज्ञकम् ॥
 अनेन विधिना सम्यक् शतसंख्यानि दापयेत् ।
 पुटान्येवं कृते चोष्णि शतानि द्वादशाधिकम् ॥
 पञ्चादृदे काचमये कूपे द्वात्रिंशयामकम् ।
 बालुकाग्निं प्रदद्याच्च स्वाङ्गशीतं समुद्धरेत् ॥
 तलभस्म ग्रहीतव्यं वेधयेत्तारशुद्धके ।
 शुद्धहेम भवेत्तेन नात्र कार्या विचारणा ॥
 दृष्टप्रत्यययोगोऽयं कथितो नात्र संशयः ॥

Extracts from RASACHINTAMANI.

मदनामदेवसूरिविरचितात् रसचिन्तामणेः

उद्धृताः श्लोकाः ।

सैन्धवं तोरिकां सूतं कासीसं लङ्कुचद्रवैः ।

विष्टस्य खल्वभाण्डस्य सर्वज्ञस्य दिनचयम् ॥ ७६ ॥

इष्टिकायां तदारोप्य काष्ठवद्भिर्विधौयते ।

दिनत्रयेऽप्यतिक्रान्ते भस्म श्वेततरं भवेत् ॥ ७७ ॥

* * * * *

इति त्रयोदश भस्मसूतः ।

खर्पूरो द्वादशांशः स्यात् शिखिघ्नीवं च तुल्यकं ।

षड्गुणं माषिकं नेत्रभागं द्वाष्ट्यं मनःशिला^१ ।

भागत्रयमिदं द्वाष्ट्यं शोभनागतकर्करैः^२ ॥ ३८ ॥

(1) चापि नेत्रभागा मनःशिला is the correct reading as stated in the margin of the text.

(2) त्रयो भागा अपि द्वाष्ट्याः शोभना गतकर्कराः is the correct reading as stated in the margin of the text.

गंधकत्रयमेवास्ते काचमाचौरसैर्भृशं ।
 दिनसप्तात्र कर्त्तव्या भावना महर्हं क्रमात् ॥ ३९ ॥
 अधोमुखेन यन्त्रेण तेन निःसारयेद्बुधः ।
 सत्त्वं तद्रसकस्याथ दृढं कार्य्यकरं परं ॥ ४० ॥
 अवश्यं तद्दृढं सत्त्वं निर्धूमं कर्मसाधनं ।
 इति रसकसत्त्वपातनं ।

त्रिवारं गन्धकहतं ताम्रह्मे महयत्रयं ।
 सत्त्वं तालस्य मासैकं योजयेत् सर्वकामदं ॥ ४१ ॥
 अभ्रवणं भवेद्धेमं ताम्रगंधकमारितं ।
 एतयोर्दीयते रम्यं जायते कांचनं शुभं ॥ ४४ ॥

इति श्रीमदनांतदेवविरचिते रसचिंतामणौ
 हेमीकरणप्रयोगः ॥

पारदं सीसकं गंधं कुनटो तच्चतुष्टयं ॥
 बीजपूरांभसा पिष्ट्वा बाढं दिनचतुष्टयं ॥ १०८ ॥
 अथ सूक्ष्माणि पक्षाणि तेन तारस्य लेपयेत् ।
 बीजपूररसेनैतत् स्थितिमात्रांमितापितं ॥ १०९ ॥

एकाधिका भवंत्स्र्य भावनायाश्च विंशति ।

विशोच्चावर्त्तितं तारं भवेत्तारस्य काचनं ॥ ११० ॥

इति चिन्तामणौ हेमीकरणप्रयोगः ॥

हेमभागद्वयं तारं तथा तास्रं चतुष्टयं ।

एकतः क्रियते पञ्चमतिस्फुटं निरामयं ॥ १११ ॥

जंबीरनीरसंपिष्टं खर्परस्थाष्टकं ।

तेन तान्यथ पत्राणि लेपनीयानि वै बहु ॥ ११२ ॥

आवर्त्तते पुनर्दत्त्वा मूषके गलितानि च ।

तदा तानि भवंत्स्र्य हेमरूपाणि नान्यथा ॥ ११३ ॥

इति हेमीकरणप्रयोगः ॥

एकभागो भवेदारः तारं भागद्वयं भवेत् ।

वेदभागं भवेत्तीक्ष्णं सत्वं सत्वाच्च वै द्रव्यं ।

बंगभागं भवेत्पत्रं सर्वमेकत्र कारयेत् ॥ १०८ ॥

टंकचेन पुनः स्नातं पत्रं क्षत्वाश्च वल्लभं ।

वेत्तापयमिदं स्नातं तन्ममध्ये निवेशयेत् ॥ ११० ॥

यत् तारं भवेद्भूतं परीक्षाचममापये ॥

इति तारीत्यादयः ॥

तुत्यकं पिथ्यते खल्ले त्रिफलाहिङ्गुटकणैः ।

मध्वाण्यमिश्रितं धातं सत्त्वं पातयते ध्रुवं ॥ ६८ ॥

इति तुत्यकसत्त्वपातनं ॥

खर्परः खेद्यते पूर्व्वं कौलयेन जलेन च ।

वटारोहजलेनापि पर्णचूर्णेन शोभनः ॥ ६९ ॥

गुडटंकणसंमिश्रिफलाक्वाथमर्दितः ।

मृन्मये कूपके कृत्वा धाम्यमानो भृशं च सः ॥ ७० ॥

खेतधूमोद्गमे जाति तत उत्थाप्य कूपकं ।

सावधानं करेणैव भूमौ तं चाध आनयेत् ॥ ७१ ॥

पुनश्च धाम्यते कूपः तथाजातं च तं पुनः ।

कूपकं च पुनर्भूमौ तथा तं नामयेत् पुनः ॥ ७२ ॥

सत्त्वं खर्परकस्यैतत् नागरूपं पतत्यधः ॥ ७३ ॥

इति खर्परसत्त्वपातनं ॥

Extracts from RASAKALPA.

रुद्रयामलान्तर्गतात् रसकल्पादुद्धृताः
श्लोकाः ।

शिवं नत्वा रसाधीशं चण्डिकाचरणं तथा ।
क्रियते¹ रसकल्पोऽयं रसज्ञानविशारदः² ॥ १ ॥

॥ अथ परीक्षा ॥

अतेजा अगुरुः शुभ्रो लोहहा(ऽ)चक्षुः रसः³ ।
यदा⁴ नावार्त्तयेद्ब्रह्म नोर्द्धं गच्छेत्तदा मृतः ॥ ४० ॥

(1) The text reads करोमि, which is grammatically incorrect.

(2) The reading in the text is विशारदम्, which is incorrect.

(3) The text reads रस, which is incorrect.

(4) The text reads यदामावर्त्तयेत्, which is not correct.

दन्ते शृङ्गे मणौ वेद्यौ रक्षयेत् साधितं रसम् ॥ ४२ ॥
 इति त्रीशद्रयामले रससंकेतकं नाम
 प्रथमोक्तासः ।

हेमरूप्याकं वङ्गाहि^१ लोहा लोहाः^२ षड्वीरिताः ।
 चक्रत्रिमा इमे येषां वर्त्ताद्याः स्युस्तु^३ कृत्रिमाः ॥ १ ॥

सन्तो बद्धाञ्जलिपुटो युष्मान् विज्ञापयाम्यहम् ।
 कृपासुधारसयुता दृष्टिर्यन्ये प्रदीयताम् ॥
 महारसाः स्युस्तथादावष्टौ पारदहिङ्गुले ।
 वैष्णवं शस्यकं शैलं चपलं रसकोऽमलम् ॥
 (महारसाः)

(1) The text reads वङ्गाहिः, which is grammatically incorrect.

(2) लोहिलोहा is the reading of the text, which seems to be incorrect.

(3) The text reads रीवाचांयासुक्रतिमा, which is palpably an error.

अभ्रकं तुल्यकं कान्तं राजावर्त्तमयाञ्जनम् ।

वज्रं वेक्रान्तकं चैव टङ्कणं च रसा बहु ॥

(रसाः)

गन्धकं तालकग्रिले क्षितिखेचरगैरिकाः ।

इत्यादयश्चोपरसाः सर्वार्थायैरुदीरिताः ॥

(उपरसाः)

सितासितारुणं पीतं गन्धकं तच्चतुर्विधम् ॥

तालकं द्विप्रकारं स्यात् गोदन्तः पाटलच्छविः^१ ॥

रक्ता पीता शिला द्वेधा पूर्व्या श्रेष्ठोत्तराधमा^२ ॥

बहुप्रकारा सौराष्ट्री कासीसं त्रिविधं मतम्^३ ॥

कासीसं पुष्पकासीसं ह्रीरकासीसमित्थय ॥

गैरिको द्विविधः प्रोक्तः सौवर्णो लोहितस्तथा ॥

(1) The text reads ^१पाटलाक्षवि, which seems to be incorrect.

(2) पूर्व्या श्रेष्ठोत्तराधमा is the reading of the text, which is incorrect.

(3) The text reads कासीसद्विविधो मतः, which is in correct as it is mentioned neuter in the next line.

कङ्कुटादीन्¹ रसान् केचिदाचार्या वर्णयन्ति वै ।
अस्माभिरिह तन्मोक्षं मुनिमार्गानुसारिभिः ॥

इत्येष प्रोदितो मार्गो रसशोधनकर्मणि ।
स्वच्छन्दभैरवाद्युक्तो गोविन्दादिसमाहृतः² ॥

लवणं चूलिकोद्भूतं गन्धकेन समन्वितम् ।
सर्वाङ्गदृष्टं³ चित्राद्रिं मूलभस्मप्रगालितम् ॥
गोमूत्रेण शतं भाव्यं तद्वसे जारयेत् शनौ⁴ ।
तस्य संपर्कतः सूतो राक्षसो भवति ध्रुवम् ॥

(1) The text reads कङ्कुटादीन्, which is an error of the scribe.

(2) The text reads अनादितः, which is incorrect.

(3) The text reads सर्वाङ्गदृष्ट, which seems to be incorrect.

(4) शनौ, as given in the text, is grammatically incorrect.

एतदेव विद्धं दद्यात् सर्व्वदा हेमजारणे¹ ।

मुखं संजायते तेन जौर्यते च² विनिश्चितम् ॥

इति श्रीरुद्रयामले रसकल्पे उमामहेश्वरसंवादे

रमशोधनप्रकारः ॥

इति संधानयोगोऽयं जारणेऽतिगुणावहः ॥

प्रकाशितः संप्रदायक्रमप्राप्तः शिवोदितः ॥

इति श्रीरुद्रयामले रसकल्पे उमामहेश्वरसंवादे

रसाधिकरणो³ नाम द्वितीयोऽङ्गाक्षः ॥

महारसानां सर्व्वेषां रसानां शुद्धिरुच्यते ।

तथैवोपरसानाञ्च शास्त्रदृष्टेन वर्त्मना ॥ १ ॥

कदलीपत्रजैर्नीरैः माक्षौकं भावयेत् शतम्⁴ ।

गन्धर्वतैलमध्वाण्य-पक्वमेकं दिनद्वयम् ॥

- (1) The text reads हेमजारणौ, which is not correct.
- (2) The text reads न, which appears to be an error.
- (3) The text reads रसाधिकारिणा, which is incorrect.
- (4) The text reads ब्रह्मं, which is senseless.

तत्ताप्यं वज्रमूषायां¹ पक्षायां निक्षिपेत्ततः ।
 लोहसन्धानकरणं तत्समं तच्च निष्पचेत् ॥
 दृढां प्रकल्पयेन्मूषां² कोष्ठिके³ विनिवेशयेत् ।
 अङ्गारैः खदिरोद्भूतेः धमेदुभस्त्राह्वयेन वै ॥
 वक्रनालयुजा सत्त्वं ताप्यस्य पतति ध्रुवम् ।
 शुक्लदीप्तिः सशब्दश्च⁴ यदा वैज्ञानरो भवेत् ।
 तदा सत्त्वं तु पतितं जानीयात्तान्यथा क्वचित् ॥

रसकं खेदयेदादौ⁵ पटुचूर्णकृतं बुधः ।
 चतुर्गुणेन वस्त्रेण दृढं बध्वा च डोलिकाम् ॥

(1) तत्ताप्यं वज्रमूषा is the reading of the text, which appears to be incorrect.

(2) The text प्रकल्पयेन्मूषा is evidently incorrect.

(3) कोष्ठिकानि निवेशयेत् is the reading of the text, which has no meaning at all.

(4) The text reads सशब्दश्च, which is grammatically incorrect.

(5) रसकाखेदयेदादौ is the reading of the text, which seems to be incorrect.

कृत्वा भाण्डे च सजले¹ स्वेदयेन्नासपञ्चकम् ।
 उद्धृत्य पञ्चाद्रसकं खल्लमध्ये² विचूर्णयेत् ॥
 पादौशान् मालतीजातं सगुडं जीर्णगुञ्जकम् ॥
 गृहधूमं रेवकीं च निशामं कुल्लजीरकानु³ ॥
 तत् सर्वं चर्णितं कृत्वा गोपञ्चकविभावितम् ।
 कृत्वा तद्वटिकाः पश्चात् छायायां शोषयेत्ततः ॥
 कोष्ठगेनाग्निना⁴ पश्चाद्वमेदुभस्त्राद्वयानिलैः ।
 सत्त्वं पतत्यसंदेहं स्थिररङ्गं दृढं बहु ॥
 एकमासं हिमासं वा रसकं स्वेदितं यदि ।
 न धातव्यं तच्च कोष्ठे धमेत्तत् नालमूषया ॥

— —

इति सम्पादितो मार्गो द्रुतीनां पातने स्फुटः ।
 साक्षादनुभवैर्दृष्टो न श्रुतो गुरुदर्शितः ॥

(1) कृत्वा भाण्डेन सजले .is the reading of the text, which is incorrect.

(2) The text reads खल्लमध्ये.

(3) The text has जीरका, which is grammatically incorrect.

(4) The text reads कोष्ठगेनाग्निना, which is not correct.

लोकानामुपकाराय एतत् सर्वं निवेदितम् ।
 सर्वेषां चैव लोहानां द्रावणं परिकीर्तितम् ॥
 इति श्रीरुद्रयामले रसकल्पे उमामहेश्वरसंवादे
 सर्वलोहद्रुतिपातनाधिकारः समाप्तः¹ ॥

Extracts from RASARAJALAKSHMI.

विष्णु देवविरचितायाः रसराजलक्ष्म्याः

प्रारम्भः—

यस्येच्छाद्गुरवङ्गरी मुकुलिता नानाकलाकीतुकैः
 चातुर्यैकविलोलपङ्गववती कीर्त्तिप्रसूनप्रसूः ।

(1) समाप्तं शुभम् is the reading of the text, which is not correct.

संनिर्वापयति ज्वरत्रयमहो ज्ञायाकलापैर्नृणां
सोऽयं पातु विचारमूर्तिरखिलं कालापसीदं जगत् ॥१॥

जयति दुरितसर्पस्त्रोडमंत्रोद्यदपैः

प्रवसगदविनाशः सेविविध्वस्तनाशः ।

शिव इव विज(बीज ?)मंत्रः संहितायोगमंत्रः

त्रिपुरहरतनूजस्तेजसः कायपुंजः ॥ २ ॥

इति श्रीपण्डितमहादेवतनयश्रीविष्णुदेवविरचितायां
रसराजलक्ष्म्यामुक्तासः प्रथमः ॥

दृष्ट्वेमं रससागरं शिवकृतं श्रीकाकचण्डेश्वरी-
तन्त्रं सूतमहोदधिं रससुधाशोधिं भवानीमतम् ।
व्याधिं सुश्रुतसूचमीशहृदयं स्वच्छंदशक्त्यागमं
श्रीदामोदरवासुदेवभगवद्गोविन्दनागार्जनान् ॥

प्रथमः उक्तासः ।

स्वच्छंदशक्त्यागमसारभूतः

समुद्भूतो विष्णुभिरग्वरेण ॥ ११० ॥

द्वितीयः उक्तासः ।

आलोक्ष्य सुष्ठुतं वृन्दहारोत्तरकादिकान् ।

आत्रेयं वाग्मटं सिद्धसारं दामोदरं गुहम् ॥

द्वितीयः उच्चासः ।*

* Foll. 1—43. Linn. 10. *Rasarājalakshmiś, de medicamentis mettallorum et fossilium ope conficiendis liber, a Rāmes'vara (bhatta), Vishṇus filio, compositus.* Incipit : आनन्देकरसे विकल्पकलनानिमृत्तबोधात्मकिं प्राग्ज्यावधिसंगति-
व्यपगते etc. ॥ १ ॥ स्रग्भिमुखीमयनमद्यनेन (1. स्रग्भिमुखी०) sphurad
Rasāmbhodhi-gabbhīragarbhāt । s'rf-Vishṇudevi (o devī)
labhate prayatnāt s'rf Vishṇuvatsād *Rasarājalakshmiś*
॥ 2 ॥ *Dṛishtvemaṁ Rasasāgaram, S'ivakṛitam s'rf-Karka-*
chandēs'varītantram, Sūtamahodadhim, Rasasudhām-
bhodhim, Bhavānīmatam, Vyādi[m], Sus'rutasūtram,
Is'ahridayam, Svachobhandas'aktyāgamam, s'rf-Dāmoda-
ra-Vāsudeva-Bhagavad-Govinda-Nāgārjunān ॥ 3 ॥ आनन्द-
मानन्दकरं प्रसन्नं ज्ञानस्वरूपं निजभावयुक्तम् । योगोद्गमीयं भवरीगर्भं
श्रीमद्गुहं नित्यमहं नमानि ॥ ४ ॥

महारसाः सुष्ठुतादावष्टौ पारदहिं गुह्ये ।

वेष्टवं सस्वकं श्रेष्ठं चपलं रसकोमलम् ॥ ५ ॥

चमकं तुहकं (tutthakam) कानं राजावर्तनजीवनं ।

वय्यकोकातकं (o vaikrāntakam) चेति टहकं च रसान्विदुः ॥ ६ ॥

तावकं नयकश्चिदे चित्तिचिचरनेरिकाः ।

इत्यादयश्चोपरसाः पूर्वाचारैश्चदीरिताः ॥ ७ ॥

Aufrecht's "Catalogus," p. 321, No. 761.

Colophon at the end of the Rasarájalakshmi—

राजन् (सश)शार्धरिवत्सराद्यदिवसे वारे हिमांशोरिदं
चंचदभूतलपत्तने विजयिनि श्रीबुक्कपृथ्वीपतेः ।
शास्त्रं वैद्यकसाररूपमकरोत् श्रीविष्णुदेवः कविः
वाग्देवीचरणारविंदमकरंदामोदसौरस्यवाक् ॥

Extracts from RASANAKSHATRAMALIKA

मथनसिंहविरचितायाः रसनक्षत्रमालिकायाः

उद्धृताः श्लोकाः ।

चतुश्चतुःशंखकपर्दिकानां
सतक्रान्त्यीरविमर्दितानाम् ।
आफेनमाक्षीकविषद्वयानां
पलं पलं दन्तिफलाग्नितानाम् ॥ २५ ॥

यतभस्मगन्धसूता हितयं वङ्गस्य शुद्धतीक्ष्णम् ।
 दग्ध्वा मृगस्य शृङ्गं त्रिगुणं दत्त्वा रसार्द्धविषम् ॥ १२३ ॥
 चिचकशौतशिवावृषदशमूलदिवनदविष्यगिरैः ।
 कलहत्तारविकृतकैः प्रत्येकं भावनत्रितयम् ॥ १२४ ॥
 दत्त्वा सुसिद्धमात्रो मारिचधूपेन धूपितः सम्यक् ।
 स्वच्छन्दभैरवाख्यो रसः समस्तामयध्वंसो ॥ १२५ ॥
 चिकटकरसेन युक्तो विशेषतः सन्निपातहरः ।
 ग्रहणिगदामयशूलव्रणविद्रधिवातगुल्मजयी ॥ १२६ ॥
 इति स्वच्छन्दभैरवो रसः ॥*

इयं मालविभूपालभिषजा भिषजां मता ॥
 कृता मथनसिंहेन रसनक्षत्रमालिका ॥ १४२ ॥

इति रसनक्षत्रमालिका समाप्ता ॥ स्वस्ति
 संवत् १५५७ आश्विन कृष्ण ५ सोमे ।

* The स्वच्छन्दभैरव रस mentioned in the रसनक्षत्र-
 मालिका is quite distinct from that, which is stated in
 the रसैन्द्रचिन्तामणि. Neither has it any analogy with
 what is described in the रसरत्नमुच्चय.

Extracts from RASARATNAKAR

नित्यनाथविरचितात् रसरत्नाकरात्
उद्धृताः श्लोकाः ।

यदुक्तं शम्भुना पूर्वं रसखण्डे रसार्णवे ।
रसस्य वन्दनार्थं च दीपिकारसमङ्गले ॥
व्याधितानां हितार्थाय प्रोक्तं नागार्जुनेन यत् ।
उक्तं चर्पटिसिद्धेन¹ स्वर्गवैद्यकपालिके ।
अनेकरसशास्त्रेषु संहितास्त्रागमेषु च ।
यदुक्तं वाभटे तन्मे सुश्रुते वैद्यसागरे ॥
अन्येषु बहुभिः सिद्धैः यदुक्तञ्च विलोक्य तत् ।
तच्च यद्यदसाध्यं स्याद्यद्यदुद्गर्भमौषधम् ॥
तत्तत् सर्वं परित्यज्य सारभूतं समुद्धृतम् ॥
कचिच्छास्त्रे क्रिया नास्ति क्रमश्चापि न च कचित् ।

(1) चर्पटिसिद्धेन is the reading in the Sanskrit college-
MS.

मात्रायुक्तिः कचिन्नास्ति सम्प्रदायो न च कचित् ।

तेन सिद्धिर्न तत्रास्ति रसे वाय रसायने ॥

वैद्ये वादे प्रयोगे च तस्मादयन्नो मया कृतः ।

यद्यदगुरुमुखाज्ज्ञातं खानुभूतञ्च यन्मया ।

तत्तत्तत्कहितार्थाय प्रकटीक्रियतेऽधुना ॥

प्रथमोपदेशे ।

इति श्रीपार्व्वतोपुन्ननित्यनाथसिद्धविरचिते रसरत्नाकरे

रसखण्डे रसपीठिका नाम प्रथमोपदेशः ।

परीक्षा मारिते सृते कर्त्तव्या च यथोदिता ।

अधसुषाम्निना तप्तो ह्यक्षौणस्तिष्ठते यदा ।

तदा भस्म विजानीयाच्चुक्लरां यामं निरीक्षयेत् ॥

द्वितीयोपदेशे ।

दन्ते शृङ्गेऽथवा वंशे रक्षयेत् साधितं रसम् ॥

चतुर्थोपदेशे ।

अथातः शुद्धसूतस्य मूर्च्छनाविधिद्वयते ।

मेघनादावचाहिर्गुशूरणैर्मर्द्दयेद्रसम् ॥

नष्टपिष्टन्तु तद्गोलं हिङ्गुना वेष्टयेद्दृष्टिः ।
 पचेन्नवययन्मस्यं दिनैकं चण्डवङ्किना ॥
 ऊर्ध्वलम्बं समादाय दृढं वस्त्रेण बन्धयेत् ।
 ऊर्ध्वाधो गन्धकं तुल्यं दत्त्वा सोमानले पचेत् ॥
 जीर्णे गन्धे पुनर्देयं षड्भिर्वारेः समं समम् ।
 षड्गुणे गन्धके जीर्णे मूर्च्छितो रोगहा भवेत् ॥
 चतुर्थोपदेशे ।

Extracts from DHATURATNAMALA.

धातुरत्नमालायाः

प्रारम्भः—

प्रथम्य वितर्तीं शक्तिं विसृष्ट्यत्यन्तिकारिणीं ।
 धातूनां रत्नमालायामभिधायं करोम्यहं ॥ १ ॥
 ब्रह्मविष्णुहराद्यान् ये मर्त्ता ध्यायन्ति निस्त्रयः ।
 ज्ञानदानप्रदानाय सा मे विष्णोश्चरी मता ॥ २ ॥

अथ धातूनां रत्नमालां वक्ष्यामि ।

रौप्यं हेमं तथा ताम्रं नागं वंगं तथायसं ।

खर्पराम्बकमीक्षं च प्रबालं तालकं शिला ॥ ३ ॥

सुवर्णमाक्षिकं सूतं ह्योरकं च ब्रवीम्यहं ।

सर्वधातूपधातूनां लक्षणं मारणं गुणं ॥ ४ ॥

अथ रौप्यमारणं ।

रौप्यं शुद्धं समादाय नागेन गुरु शोधयेत् ।

शुद्धे तारे पुनः पश्चात् सूक्ष्मपत्राणि कारयेत् ॥ ५ ॥

निंबचिंचिषिद्राक्षामिः शोधयेच्च पृथक् पृथक् ।

ज्वालयेदुदकैः सार्धं तथा दुग्धेन शोधयेत् ॥ ६ ॥

गंधपारदयोरेकं किञ्चिद्द्वगं च घर्षयेत् ।

द्राक्षाया द्रवसंयुक्तं तारपत्राणि शोधयेत् ॥ ७ ॥

चक्रयन्त्रे विनिक्षिप्य लेपयेद्वस्त्रमृत्तिकां ।

क्षिपेद्गजपुटे गर्त्ते ज्वालयेद्बहुह्वानकान् ॥ ८ ॥

समाप्ति :—

ग्रंथो वैद्यकनामायं रससिद्धांतसागरात् ।

धातूनां रत्नमाला च ततो वैद्यस्य हेतवे ॥ १७६ ॥

मरणेभ्यो भयत्रस्ता रोगयस्ताश्च ये नराः ।

रत्नमाला कृता तेषां वैद्यानां च हिताय वै ॥ १७७ ॥

इति त्रीवैद्यकशास्त्रे चण्डिनौकुमारसंहितायां

धातुरत्नमालायां समाप्तोऽयं ग्रन्थः ।

The following is taken from Aufrecht's
"Catalogus"—No. 760.

Incipit :—प्रणम्य सारदां शक्तिं सृष्टेरसत्ति-
कारकां । धातूनां रत्नमालां च विबोधाय करोम्यहं
॥ १ ॥ ब्रह्माविष्णुहरान् ध्यायेद्ब्रह्मा ध्यायन्ति नित्यशः ।
तेषां वरप्रदानाच्च सा मयैवमुदीर्यते ॥ २ ॥ रूप्यं
हेम तथा ताम्रं नागं वंगं तथायसं । स्वर्परां गगनं
प्रोक्तं प्रबालं तालकं शिला ॥ ३ ॥ माचिकं गंधकं
सूतं हीरकं च ब्रवौम्यहं । सर्वधातूपधातूनां लक्षणं
मारणं गणान् ॥ ४ ॥ रूप्यं शुद्धं समानीय नाग-
मूषा नु शोधयेत् । शुद्धे तारे पुनः पश्चात् सूक्ष्म-
पत्राणि कारयेत् ॥ ५ ॥ निंबुचिंचिणीद्राक्षाभिः शोधनीयं
पृथक् पृथक् । क्षालयेद्दुदकैः साधं तथा दुग्धेन
शोधयेत् ॥ ६ ॥ गंधकं पारदं रूप्यं किंचिद्वर्गं च

घर्षयेत् । द्वाचारसेन संयुक्तं तारपत्राणि लेपयेत्
 ॥ ७ ॥ नक्तं यन्त्रे विनिलिप्य लेपयेद्वस्त्रमृत्तिकां ।
 क्षेप्यं गजपुटे गर्त्ते ज्वालयेच्च ग्रहोपलैः ॥ ८ ॥

In fine libelli disticha haec leguntur :

ग्रंथो वैद्य [क] नामायं Rasasiddhāntasāgarāt ।

धातूनां रत्नमाला च कृता वैद्यसुहेतवे ॥ १ ॥

मरणेभ्यो भयत्रस्ता रोगग्रस्ताश्च ये नराः ।

रत्नमाला हि धातूनां कृता तेषां हिताय वै ॥ २ ॥

Jātyā Gurjarakhandas cha, Devadatto

hi dharmavit ।

Harer nāmābhidhānasya सुतस्तस्य भिषग्वरः ॥ ३ ॥

संहितारसकर्माणि यस्य बुद्धिर्गरीयसी ।

तेन शास्त्रविधिज्ञेन कृता रत्नस्य मालिका ॥ ४ ॥

इति देवदत्तकृतवैद्यकशास्त्रे धातुरत्नमाला ॥

Extracts from RASAPRADIPA.

रसप्रदीपादुद्धृताः श्लोकाः ।

A—MS. from Alahabad.

B—MS. from Benares.

अथ शङ्खद्रावरसः ।

स्फटिका¹ नवसारस्य सुश्लेता² च सुवर्चिका ।
पृथक् दशपलोद्भानं गन्धकः पिचुसंमितः³ ॥
चूर्णयित्वा क्षिपेद्भाण्डे मृन्मये मृद्विलेपिते⁴ ।
तन्मुखं मुद्रयेत् सम्यक् मृदभाण्डेनापरेण च ॥
सरन्ध्रोदरकेणैव चुल्लगां तिर्यक् च धारयेत् ।
अधः प्रक्षालयेद्दङ्गिं हठादयावद्रसः सवेत् ॥

(1) A reads स्फटिका, B. reads स्फुटिका.

(2) B reads सुश्लेता, which is not correct.

(3) B reads पिसंसिचुतः, which is not correct.

(4) मृत्ति¹ लेपिते is the reading in B.

शास्त्रेकं सेवयेद्व्यङ्गात्¹ दन्तस्पर्शविवर्जितम् ।
 गुणोदरयुक्तत्प्रीत्यन्यिच्छादिशूलनुत् ॥
 बलपुष्टिप्रदो ह्येष भुक्तं च जारयेत् क्षणात् ।
 विलोक्षतां महालोका रसमाहात्म्यमद्भुतम् ।
 कपर्दकाश्च लोहानां यस्मिन् चित्ता² गलन्ति हि ॥

फिरङ्गव्याधिः—

गैरिकं रसकर्पूरम् उपला च पृथक् पृथक् ।
 टङ्कमात्रं विनिष्पिच्य³ ताम्बूलोदलजैः रसैः ॥
 बद्धचतुर्दशांशोपा⁴ कर्तव्या भिषगुत्तमैः⁵ ।
 सायं प्रातः समञ्जीयात्⁶ एकैकां दिनसप्तकम् ॥

- (1) B reads बद्ध.
- (2) A reads चित्ता.
- (3) A reads विनिःस्पिच्य.
- (4) A reads चतुर्दशांशोपा. B reads चतुर्दशोपा.
- (5) B reads भिषगुत्तमौ, which is incorrect.
- (6) B reads समञ्जीयात्, which is incorrect.
- (7) दिनसप्तकं an incorrect variant in B.

सष्टता योलिका^१ देया भोजनार्थं निरन्तरम् ।
फिरङ्गव्याधिनाशाय वटिकेयमनुत्तमा ॥ *

(1) गोधूमरीटिका इत्यर्थः.

* The following is taken from वीनतरङ्गिणी of Tri-mallabhatta, printed in Bombay in the S'aka year 1810.

यत्र सुसिद्धे जलकसमाख्ये
निधाय सूतस्य पत्रानि पञ्च ।
बन्धोक्तस्तत्त्वाखटिकैटिकानां
सर्गेरिकानां तुवरयुतानाम् ॥ ६० ॥
ससैधवानां समभाजिकानां
चूर्णादकं चोपरितो निदध्यात् ।
चखेन दत्ता मङ्गिणीभवेन
पिष्टं रसीनस्य शरावमेकम् ॥ ८१ ॥
समक्रमेणात्र निधाय खण्डे-
राच्छादयेत् खर्परजैर्विसंधि ।
चूर्णप्रलितोदरमूर्ध्वभाजं
संख्याय संमुद्रा दृढं सुषुम्णाम् ॥ ६९ ॥
प्रज्वालयेदग्निमथः क्रमेण
संख्याय यंचोपरि वस्त्रमाद्रंम् ।
बहिः प्रदद्याद्दिनवट्कमत्र
तत् स्नातृश्रीतं पश्येत्तत्र बुद्ध्या ॥ ६९ ॥

चन्द्रोदयाख्य रसवर्णने—

काशे श्वासे फिरङ्गाख्ये रोगे च परमो हितः ।

अथ उपायान्तरम्—

सुशब्दा¹ कुलकञ्चैव² पारसीकयमानिका ।

भक्तातकफलं चापि पलमानं पृथक् पृथक् ॥

तं द्रोणपुष्पीपयसा प्रपिष्टं

कूप्यां विदध्यान्नवसादरं च ।

कर्षप्रमाणं प्रहरत्रयं च

वज्रं प्रदद्यादथ शीतलांगीम् ॥ ६४ ॥

निष्कास्य कूपीं सिकताख्यया-

दाक्षीव्य कठस्थनमुं प्रगृह्यात् ।

कपूर्वनामा रसनायकोऽयं

वज्रः पुराणेषु गुणेन भुक्तः ॥ ६५ ॥

निर्वर्जिभाजा सवजा च पथ-

शीलेन कुष्ठामयनाशनः स्यात् ॥

फिरङ्गकरिकेशरी सकलकुष्ठकालानली-

ऽखिलत्रयविनाशकद्वन्द्वजगर्भपूर्णिप्रदः ।

सुवर्णसमवर्णं कृत्वा हुताग्नेतेजस्करः

समस्तगदतस्करो रसपतिः स कर्पूरकः ॥ ६६ ॥

इति कर्पूररसः बौद्धसर्वस्वात् ।

(1) B reads सुशब्दा.

(2) B reads कर्णकं चैव.

पलार्चमानः सूतः स्यात् षट्पत्नीऽत्र शुद्धः स्मृतः ।

एकीकृत्याखिलं कुर्यात् वटीः कर्षप्रमाणतः ॥

खादेदेकां वटीं प्रातर्यावदारोग्यदर्शनम् ।

गोदध्नश्चानुपानेन फिरङ्गामयनाशिनौ^१ ॥

निम्बुकेन^२ विना नैव वर्जनैयमिहापरम् ॥

अथ उपायान्तरम्—

चोपचीनीभवं चूर्णं शाणमानं समाक्षिकम् ॥

फिरङ्गव्याधिनाशाय भक्षयेज्जवणं त्वजेत् ॥

(1) B reads फिरङ्गापविनाशिनौ.

(2) B reads निम्बुकेन.

Extracts from DHATUKRIYA or DHATUMANJARI.

रुद्रयामले धातुक्रिया धातुमञ्जरी वा । *

श्रीगणेशाय नमः ।

पार्श्वस्थुवाच ।

अयानन्तर^१ देवेश ब्रूहि धातुसुसंस्कृतिम्^२ ।

येन विज्ञानमात्रेण साधयेद्धातुसंज्ञितः ॥ १ ॥

महादेव उवाच ।

धातुस्तुर्यविधः प्रोक्तः तुर्यस्तुर्ये स्वपक्षतः (?)^३ ।

सर्वं रजस्तमश्चैव चतुर्यस्तु निरामयः ॥ २ ॥

* The Ūlwar MS. (A) reads धातुक्रिया, a part of the Rudrayāmala ; but the Benares MS. (B) reads धातुमञ्जरी, a part of the same. The two MSS. are exactly the same in subject matter, differing only in name.

(1) A reads अयानन्तर, which is grammatically incorrect.

(2) A reads धातुसु संस्कृति, which is grossly incorrect.

(3) The sense here is not clear.

राजसे राजसी सिद्धिस्तामसे तामसी सदा ।

सत्त्वसाधनं सात्त्विको ज्ञानीते¹ सर्वसाधनम् ॥ ३ ॥

पार्वत्यवाच ।

कथ्यतां देवदेवेश सत्त्वं राजसतामसम् ।

अतीव गुणवत्² धातोः कार्यं लक्षणलक्षितम्³ ॥ ४ ॥

उपधातुक्रमेणैव तेषां लक्षणसाधनम् ।

विटकी च मुदा युक्ता तेषां कर्मसु⁴ साधनम् ॥ ५ ॥

उपकारो⁵ गुणलक्षं नाना कार्यक्रिया शुभा ।

वियोगयोगचाञ्चल्यं वर्णभेदैस्तु मारणम् ॥ ६ ॥

समग्रं देवदेवेश विशेषा धातुक्रियाः ।

येन विज्ञानमात्रेण साधयेत् गन्धकीः क्रियाः ॥ ७ ॥

(1) A reads ज्ञानीते, which seems to be incorrect.

(2) A has गुणवती, which appears to be incorrect.

(3) कार्यं लक्षणलक्षितम्, a variant in A, which is not correct.

(4) A reads erroneously कर्मसु.

(5) A reads उपकार, which is grammatically incorrect.

महादेव उवाच ।

पृथिव्या गर्भमध्ये तु अनेका धातुस्तिष्ठति^१ ।
 विस्तृता^२ कियत्कालेन धातुर्नानाविधोदिता^३ ॥ ८ ॥
 गुणलक्षणभ्युक्ता^४ साम्प्रतं न स्मरामि ह^५ ।
 कथं ते कथयिष्यामि^६ वद ब्रह्माण्डवासिनि ॥ ९ ॥

पाव्वत्युवाच ।

ये केचित् स्मर्यन्त^७ ईश व्यक्तं कथय साम्प्रतम् ।
 भवतो^८ऽनुग्रहेणैव साधनार्थस्य^९ सिध्यति ॥ १० ॥

(1) अनेका धातु तिष्ठति, a variant in A, which treats the word धातु in the neuter as well as in the feminine genders.

(2) A reads विस्तृता, which is not correct.

(3) धातुर्नानाविधोदिता, an incorrect variant in A.

(4) A reads संयुक्ता, which is grammatically incorrect.

(5) A reads स्मरति ह, which is incorrect.

(6) कथयामास is the incorrect reading in A.

(7) A and B read स्मरते, which is grammatically incorrect.

(8) भवता is the reading in A and B, which is not correct.

(9) साधनार्थस्य is the incorrect reading in A and B.

महादेव उवाच ।

शृणु देवि प्रवक्ष्यामि धातुं नानाविधस्थितिम् ।

गुणलक्षणसंयुक्तां यथा बुद्धिः^१ कथिष्यति ॥ ११ ॥

मुख्यप्राधान्यता^२ एते रङ्गलोहक^३ताम्रकैः ।

रजतेनैव^४ संयुक्ता धातोस्तमता सदा ॥ १२ ॥

मध्यमा सत्त्वजा धातुः^५ नीचा च त्रपुसीसयोः ।

संयोगे धातुनामा हि नीचा नीचतरा स्मृता ॥ १३ ॥

संयोगान्ते त्रिधा प्रोक्ता उत्तमा मध्यमाधमा ।

ताम्रजासत्वयोर्योगि^६ नारीधातुः प्रजायते ॥ १४ ॥

(1) A and B read बुद्ध्या

(2) मुख्यप्राधान्यता is the correct reading. प्राधान्यता is grammatically incorrect.

(3) A and B have रङ्गलोहकताम्रकैः, which mars the metre.

(4) A reads रजतेनैव, which is not correct.

(5) धातुः is used here in the feminine gender both by A and B.

(6) Vide verse 20.

एषा^१ मध्योत्तमा प्रोक्ता कार्यकारणयोगके ।
 अपुताम्नसंयोगेन^२ जाता धातुश्च मध्यमा ॥ १५ ॥
 सीसके^३ भङ्गदा प्रोक्ता कार्यकाले सदोदिता ।
 अनेनैव प्रकारेण येन येन च कर्मसु ॥ १६ ॥
 कर्त्तव्या जाघवो विद्या ज्ञात्वा^४ बुद्धिविशारदेः ।
 अभङ्गं सीसके जातं शुद्ध उत्पत्त्यकारकम् ॥ १७ ॥
 हाटके खेतता जातेः^५ अक्षया^६ रजते यदि ।
 लघुद्रावः शुभे शुष्के लोहे च द्राविणो कला ॥ १८ ॥

(1) Both A and B read एतत्, which is grammatically incorrect.

(2) संयोगे is the reading in A and B, which mars the metre.

(3) A and B reads शीशके.

(4) A reads ज्ञात्वा, which is incorrect.

(5) A and B read जाते, which is incorrect.

(6) A reads अक्षयो. B reads अक्षयी. Both the readings seem to be incorrect.

जासत्वे चङ्गहीना च कार्ठव्याभ्यधिकौ परौ ।
 कला एताश्च धातूनां जातेर्भवति शुद्धता^१ ॥ १८ ॥
 कला एतादृशौ दिव्याः प्राप्तः^२ सिद्धस्तु जायते ।
 शुक्लजासत्त्वसंयोगे नारीधातुस्तु^३ जायते ॥ २० ॥
 कार्थानिककरी प्रोक्ता पात्रामोदस्तु^४ कोमला ।
 मारणे जारणे दिव्या चारणे त्रोटने तथा ॥ २१ ॥
 निर्गन्धा वर्णरहिता जातिभेदकरी स्मृता^५ ।
 एतावद्^६ गुणसंयुक्ता कार्यकारणसंयुता ॥ २२ ॥

(1) जाते भवति शुद्धताः, a variant in A. जाते भवति रशुद्धिवाः, an incorrect variant in B.

(2) A and B read प्राप्ते, which is grammatically incorrect.

(3) A reads नारीधन्यत्वस्तु. B reads नारीधन्यत्वस्तु. Both seem to be incorrect. (Vide verse 14.)

(4) B reads पात्रामोदस्तु, which is unintelligible.

(5) A reads मता.

(6) Both A and B read एतद्, which destroys the metre.

संस्कारे: संस्कृता सर्व्वैः^१ सर्व्वसिद्धिकरी स्मृता ।
 नानासुवर्णकार्येषु रूप्यकार्येषु संयुता ॥ २३ ॥
 धातुधौता च या^२ धातुः सुधामायःसुसंस्कृता ।
 कार्यसिद्धिकरी^३ श्रेष्ठा ज्येष्ठकार्यविधायिका^४ ॥ २४ ॥
 सर्व्वथाश्च सुधामायः^५ आसग्रहणग्राहकः (?) ।
 ग्राहयेत् आसमात्रेण पाचयेद्ग्रहणं^६ स्त्रियम् ॥ २५ ॥
 स्वकौयाशनसंपक्वे^७ जाते भवति सिद्धिदा ।
 अन्यथा नैव सिध्यन्ति जायते मृग-अश्ववत् ॥ २६ ॥

(1) A and B want सर्व्वैः, thus rendering the foot incomplete.

(2) A and B read ये, which is not correct.

(3) कार्यसिद्धिकरी is the variant in A and B.

(4) A and B read विधायिका, which is grammatically incorrect.

(5) A has an incomplete foot सर्व्वतेषुवा. B also has सर्व्वो तेसुवा.

(6) A reads पाचयेत् ग्रह. B reads पाचयेत् ग्रहं. Both of them seem to be incorrect.

(7) B reads संयुक्ते.

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तस्मात्तेनैव यत्नेन सुधामायः^१सुसंस्कृतिः ।

यद्योक्तसंस्कृतियुता^२ सर्वतो धातुवृत्तमा^३ ॥ २७ ॥

क्रियोचितसुसंस्कारान्^४ कारयेद्यत्नतः सदा ।

यद्योदितैस्तु संस्कारैर्युक्ता कार्य्यकरी सदा ॥ २८ ॥

सर्वसंज्ञसंयुक्ता धातुधीता सदैव हि ।

जायते नैव सम्येहः कार्य्यकारणकारिका^५ ॥ २९ ॥

पार्ष्वत्वाच्च ।

कियत्परिमिता धातुः संख्या वदतु मे विभो ।

उत्पत्तिर्लक्षणं तेषां स्थानं चैव^६ पृथक् पृथक् ॥ ३० ॥

(1) A reads सुधासाय. B reads सुधासाय. Both are unintelligible.

(2) Both A and B read संयुक्ता, which mars the metre.

(3) सर्वे ते धातुवृत्तमाः, a variant in A and B, which is grammatically incorrect.

(4) A and B read only संस्कारा, which is incorrect.

(5) Both A and B read कारकाः, which seems to be incorrect.

(6) B reads स्थानं तेषां.

कथ्यतां देवदेवेश लक्ष्यलक्षणसंस्कृतिः ।

भेदोऽभेदोऽयं^१ योगश्च मारणं चारणं तथा ॥ ३१ ॥

पातनं द्रावणं चैव त्रीटनं जारणं तथा ।

सारणं जौवनं षण्डं गोपनं लेपनं पुनः^२ ॥ ३२ ॥

जातिभेदः सुगन्धश्च मेलनं जरणं परम् ।

समग्रं कथ्यतां देव उपधातुकरौ क्रिया ॥ ३३ ॥

महादेव उवाच ।

शृणु देवि प्रदक्ष्यामि धातुस्थानानि लक्षणम् ।

उपधातुरनेका हि^३ तेषां मारणचारणम् ॥ ३४ ॥

अक्षयं राग(?)^४कारं च शोधनं बन्धनं तथा ।

मारणादि च यत् प्रोक्तं तत् सर्वं श्रूयतां श्रमे^५ ॥ ३५ ॥

(1) भेदाभेदाय is the incorrect reading in A and B.

(2) A reads युतः, which is senseless.

(3) उपधातुरनेकानि, an incorrect variant in A and B.

(4) Both A and B want this word, which may be supposed to be राग or बल here.

(5) तत् सर्वं कथयामि ते, a variant in A.

पार्वत्युवाच ।

प्रथमं वद देवेश धातुगुणक्रमसंक्षेपम् ।

प्रत्येकस्थानरूपं हि गुणसम्बन्धकारकम् ॥ ३६ ॥

महादेव उवाच ।

शृणु देवि प्रयत्नेन सिद्धान्तवचनं मम ।

येन विज्ञानमात्रेण जायते धातुक्रतुक्रिया ॥ ३७ ॥

प्रथमे धातुनामानि संक्षेपात् कार्थ्यकारणम् ।

कथयामि च ते भद्रे पश्चात् स्थानस्य संपदः^१ ॥ ३८ ॥

आदौ सुवर्णनामानि संक्षेपात् शृणुतां प्रिये ।

स्वर्णं सुवर्णं सूर्यैश्च हाटकं वज्रिरोचनम् ॥ ३९ ॥

सु(स) रङ्गं च तथा लोहं देवधातुर्मनोहरम् ।

वेशी^३ विश्वासगं चैव धर्मदं क्षपिदेवता ॥ ४० ॥

जीवनम् अमृतं चैव हिमं^३ हिमवतोद्भवम्^४ ।

देववज्रभगं दिव्यं संसारोत्तारणं महत् ॥ ४१ ॥

(1) Both A and B read संपदि, which has no sense.

(2) A reads वशी.

(3) हिम is generally used

(4) हिमवदुद्भवं is the correct term.

जीवनं सर्वलोकानां¹ नारीणां रञ्जनं शुभम् ।
 अग्न्यानि विविधानामानि² गोप्यगोप्यतराणि च³ ॥ ४२ ॥
 रजतं च तथा रूप्यं चन्द्रश्चन्द्रस्य दीपकम् ।
 शुभ्रज्योतिःकरं⁴ स्वर्णेषद्वीजं तारकं तथा ॥ ४३ ॥
 अमन्ता वर्तते तेषां कथा वृद्धिकराश्च ये ।
 स्थापितं लौकिकं चेव⁵ येनायन्वसमूहनम् ॥ ४४ ॥
 शीतवीर्यं सघुवीर्यं विषघ्नं वातनाशनम् ।
 रसपुष्पीकरं औदं धातुपुष्पनकारकम् ॥ ४५ ॥

(1) The first term in the previous verse is only जीवनं. But here it is सर्वलोकजीवनं. Hence there is no repetition.

(2) अग्न्यानि विविधान् नामान्, an incorrect variant in A and B.

(3) गोप्यगोप्यतराणि च is the reading in A and B, which has no clear sense.

(4) A and B read शुभ्रज्योतिःकरं, which is incorrect.

(5) A reads लौकिका देवा, which leaves out चेव.

रतिदं बहुवीर्यं च शुभधाम च संक्षयम् ।
 एतानि रत्नतन्त्रानि शतान्यन्यानि सन्ति वै^१ ॥४६॥
 ताम्रं च^२ त्र्यम्बकाधिष्ठं शुक्लं नागस्य मर्द्दनम् ।
 नीलं च नीलविभ्रमं वसनं^३ चैव पातकम् ॥ ४७ ॥
 उष्णम् उष्णकरं सिद्धं कृकशं कालमर्द्दनम् ।
 हेमगर्भं^४ च कामोदं विषदं विषनाशनम् ॥ ४८ ॥
 भारत्तश्च सहायश्च^५ मन्मथो मार एव च ।
 एतानि शुक्लनामानि अन्यानि विविधानि च ॥४९॥
 जासत्वं च जरातीतं राजतं यशदायकम् ।
 रूप्यभ्राता वरीयश्च त्रोटकं कीमलं लघु ॥ ५० ॥

(1) A has शतान्यानि वर्त्तते. B has शतानानि वर्त्तते, Both the readings are grammatically incorrect.

(2) च is dropped in A and B.

(3) The sense of नीलविभ्रमं seems to be नीलविषमं—नीलविषमम्. A reads चमनं, which is incorrect.

(4) A reads हेमगर्भे.

(5) A and B read सहायश्च.

चर्मकं खर्परं चैव रसकं रसवर्द्धकम्^१ ।
 सदापथ्यं बलोपेतं पीतरागं सुभक्षकम् ॥ ५१ ॥
 एतत्तु^२ खर्परनाम कार्यकर्मसु सिद्धिदम्^३ ।
 रसराजार्द्धकं कर्म^४ कृतं सिद्धिषु^५ जायते ॥ ५२ ॥
 त्रपुस्तापहरं वक्त्रं रजतारिखं^६ नीरदम् ।
 शीतवीर्यकरं श्रौतं रतिदं तापहारकम् ॥ ५३ ॥

(1) रसवर्द्धक, the reading in A and B, is not grammatically correct.

(2) तत्ते is the reading in A and B; which is incorrect.

(3) Both A and B read कार्यकर्मसु सिद्धिदान्, which is grammatically incorrect.

(4) रसराजार्द्धकान् कर्मान्, an incorrect variant in A and B.

(5) A reads कृते सिद्धिषु. B reads कृते सिद्धिषु. Both are incorrect.

(6) Both A and B read रजतानि च, which is senseless here.

मेहन्नं माह्लाद(?)भूतं सहायं धातुशेषयोः ।
 एतानि त्रयुनामानि सुसिद्धं कार्यकारकम्^१ ॥ ५४ ॥
 सौप्तिकं^२ धातुभङ्गं च मृतकं रोचकं परम् ।
 रक्तं च रक्तवीर्यं च^३ रक्तवस्तुविवर्धनम् ॥ ५५ ॥
 अन्तरूप्यं च गन्धोरं धातुभञ्जनकारकम् ।
 ग्राहकं रसर्राजेन अक्षीभ्याक्षोभणं परम् ॥ ५६ ॥
 विचित्रं विनतं चैव नानारङ्गप्रदायकम् ।
 नागं नगालयं प्रोक्तं सिद्धकं कण्ठशोधनम् ॥ ५७ ॥
 षण्डं षण्डकरं^४ चैव दुरितं षण्डकारकम् ।
 एतानि^५ नागनामानि कार्यकाले प्रयोजयेत् ॥ ५८ ॥
 लोहं च आयसं शूरं सूर्यकर्मविशारदम् ।
 हस्तकं खननं खर्णमारकं^६ ताटकं मलम् ॥ ५९ ॥

(1) सुसिद्धे कार्यकारकान्, an incorrect variant in A and B.

(2) A and B read शौप्तिकं.

(3) B has only रक्तं बीर्यं च, which is incomplete.

(4) A reads ख'डं ख'डकरं चैव.

(5) A and B read एतत्ते, which is incorrect.

(6) A has खर्णे प्रारकं. B has खर्णे मारकं

अजरं च जरायुक्तं धात्वाद्यम् अवनीसुतम् ।
 कालेयं जीषणं कालं रुधिरं रोगनाशनम् ॥ ६० ॥
 यन्निदं सर्वधातूनाम् अक्षीभ्यं जलवर्द्धिषु ।
 वर्द्धिदं वर्द्धिवीजं च सर्वधातुसहायकम् ॥ ६१ ॥
 एतानि लोहनामानि ज्ञात्वा कर्माणि कारयेत् ।
 जायते^१ सकला सिद्धिर्वियोगयोगसंयुता^२ ॥ ६२ ॥
 नामानि धातुसंयोगे जातानि तानि च शृणु^३ ।
 शुक्लस्वर्परसंयोगे जायते पित्तलं शुभम् ॥ ६३ ॥
 पित्तलं चैव नारीकं कफदं गन्धदुर्जयम् ।
 वर्णदं दुर्बलं चैव राजतं वज्रभं लघु ॥ ६४ ॥
 वज्रताम्रसंयोगेन जायते तेन^४ कांस्यकम् ।
 कांस्यकं कोमलं चैव नैरसं रसकाठिनम्^५ ॥ ६५ ॥

(1) A reads जायते.

(2) वियोगायोग is the variant in A. विषीगायोग is the variant in B. Both the readings seem to be incorrect.

(3) जातानि च ते शृणु, an incomplete variant in A and B.

(4) A has जातेनैव. B has जायते तेनैव.

(5) A and B read erroneously कठिनं.

तीव्रनादं महाशब्दम्¹ उग्रकान्ति रविग्रहम् ।
 ज्वालापिधानं रौद्रं च ग्राहकं² धूम्ररोधनम् ॥ ६६ ॥
 एतानि³ कांस्यनामानि कार्यकाले प्रयोजयेत् ।
 बन्धने धारणे चैव मुद्रणे धूमबन्धने ॥ ६७ ॥
 स्वर्परैः सह पारदं दिव्यं⁴ किञ्चित् प्रमेलयेत् ।
 जायते रसको नाम नानारोगहरो भवेत् ॥ ६८ ॥
 नागस्तु रहते⁵ होनो मृतधातुस्तु जायते ।
 स एव कोमलाग्निस्थः⁶ सिन्दूरं जायते ध्रुवम् ॥ ६९ ॥

(1) A reads महाशब्दं. B reads महत्शब्दं. Both the readings are incorrect.

(2) A reads ग्राहकं, which has no clear sense.

(3) And B read एतानि, which is incorrect.

(4) पारदो दिव्यो is the reading in A and B, which is incorrect.

(5) B reads रहते, which is not correct.

(6) कोमलाग्निस्थे is the reading in A and B, which is not correct.

अनेकाः¹ साधयेद्दद्या मन्त्रयन्त्रकारीः क्रियाः ।
 पूजनार्थे मम गुणाः सर्व्वे कल्पितरीचनाः² ॥७०॥
 ताम्रदाहजलैर्योगि जायते तुल्यकं शुभम् ।
 नाना रसायनी विद्या साधयेत् सा³ सदैव हि ॥ ७१ ॥
 रसरसक(?)⁴योगेषु राजमर्यादा जायते ।
 राजकं जायते नाम नारी राजकलागतिः⁵ ॥ ७२ ॥
 संयोगे साधनं दिव्यं वियोगे साधनं शुभम् ।
 वियोगं पुननैर्योगं रसताम्रे शुभो विधिः⁶ ॥ ७३ ॥

(1) A reads अनेका. B reads एतेका. Both are incorrect.

(2) A and B read कल्पितरीचन'.

(3) सा is not found in A and B.

(4) A and B read रसरसयोगेषु, which is incomplete.

(5) नाराराजकलागतिः, a variant in A. नाराजकलागतिः, a variant in B. Both the readings seem to be incorrect.

(6) A and B read शुभविधिः.

अनेका साधनी विद्या साधयेद्द्व्यकाङ्क्षितम्¹ ।
 लभते रसायनीं विद्यां स्वस्थोऽपि विद्वतोद्यमी ॥७४॥
 अनेनेव प्रकारेण ज्ञायते नाम कर्मभिः ।
 नामकर्मज्ञता² जाते चित्ते निर्मलता³ भवेत् ॥७५॥
 एतत्ते कथिता धातोरुपधातोस्तु तां⁴ शृणु ।
 येन विज्ञानमात्रेण कालकाव्या⁵ न लिप्यते ॥ ७६ ॥
 उपधातोस्तु मध्येषु श्रेष्ठा माता रसायनी ।
 तस्या नामानि वक्ष्यामि पश्चात् स्थानगुणानपि⁶ ॥७७॥

(1) A reads द्रव्यकोखिनः. B reads द्रव्यकाङ्क्षितः.

(2) A and B read नामकर्मज्ञता, which is unintelligible.

(3) A and B read निर्मलता, which is not grammatically correct.

(4) A and B read ते, which is incorrect.

(5) A reads काव्यकाव्यू. B reads काव्यकाव्यू. Both the readings are incorrect.

(6) Both A and B read गुणानि च, which is incorrect.

हरितालं विसङ्गा च रङ्गदीप्तिकरी सदा ।
 तालं च हरिता हंसी श्वेतपीतविधायिनी ॥ ७८ ॥
 नर्त्तकस्य प्रिया देशी निशा चैव निशाचरी ।
 पारदस्य क्षयकरी पक्षच्छेदकरी स्मृता^१ ॥ ७९ ॥
 रोगघ्ना जीविनी जेत्री जरादारिद्र्याश्रिनी ।
 एतानि तालनामानि संचेपात् कथितानि ते^२ ॥ ८० ॥
 युक्तो ज्ञानेन यः^३ कर्त्ता अक्षोभ्यो^४ जायते सदा ।
 अनेनैव प्रकारेण कर्त्ता कर्माणि साधयेत् ॥ ८१ ॥
 मनःशिला शिला शृङ्गी कुनटी च कृतोद्यमा ।
 दरदा^५ भगिनी देशी सिन्दूरस्य सखी सदा ॥ ८२ ॥

(1) The 78th and 79th slokas are not found in A.

(2) संचेपे चिकथानिजे, a variant in A and B, which has no sense.

(3) युक्तज्ञानेन ये, an incorrect variant in A and B.

(4) A reads अक्षोभ्यो, which is incorrect.

(5) B reads दरदा.

पुष्पा पुष्पवती¹ पत्री शालिनी रसिनी गुणा ।
 एतत्तु च शिलानाम² कार्यकाले प्रयोजयेत् ॥ ८३ ॥
 अभ्रकं चैव व्योम³ च गगनं ग्राहकं परम् ।
 दुष्टवीर्यञ्च वातञ्च वह्निनादोन्नताकृति⁴ ॥ ८४ ॥
 अजरम् अमरं घोरं घोरषण्डत्व⁵ नाशनम् ।
 रंसमूलरसातीतं रसञ्चै राण्यवर्धनम् ॥ ८५ ॥
 अमृतम् अमरं⁶ चैव महामृत्युविनाशनम् ।
 एतान्यभ्रकनामानि ज्ञात्वा कर्माणि कारयेत् ॥ ८६ ॥
 सोमलं मङ्गराजं च विषं वातविनाशनम् ।
 श्वेतवीर्यं बलग्रन्थि नीलउज्जलकारकम् ॥ ८७ ॥
 स्वेदनं भेदनं चैव कामवीर्यविवर्धनम् ।
 बन्धनं सर्वधातूनां मारणं पारदे रसे ॥ ८८ ॥

- (1) A reads पुष्पवती.
- (2) एतत्तु च शिला नामान्, an incorrect variant in A and B.
- (3) Generally used as व्योम.
- (4) A reads वह्निनादे एतः कृतिः, which is incorrect.
- (5) A and B read षण्डत्व, which is incorrect.
- (6) A repetition of the name.

गगनवाङ्मये दिव्ये रसयुग्मे प्रमेलनम् ।
 एतानि मङ्गलानामानि कार्य्यकाले प्रयोजयेत् ॥ ८८ ॥
 ह्रीनघातोश्च नामानि संचेपात् तानि च शृणु^१ ।
 येन विज्ञानमात्रेण जायते पारदो क्रिया ॥ ८९ ॥
 मुक्ता मुक्ताफलं वारि वारिजं स्वातिसम्भवम् ।
 शुक्तिगर्भं^२ च सगरं शृङ्गारं मङ्गलोदयम् ॥ ९० ॥
 तैजसम्^३ अमृतोद्भूतं शीतलं शिलीमं मनः^४ ।
 स्वयम्भवं कलं दौप्तं स्त्रियि सौभाग्यदायकम्^५ ॥ ९१ ॥
 रतिराजग्रहः शोभाकामसन्दीपनं तथा ।
 मुक्तानामानि रम्याणि^६ ज्ञात्वा कर्माणि कारयेत् ॥ ९२ ॥

- (1) A reads वते शृणु, which is incorrect.
- (2) B reads शुक्तिगर्भं, which is not correct.
- (3) B reads तैजसं, which is incorrect,
- (4) B reads मनः, which is not correct.
- (5) स्त्रियि सौभाग्यदायिजं, an incorrect variant in A and B.
- (6) A and B read ते रम्यान्, which is incorrect.

विद्रुमं वरदं¹ वेशावल्लीजातं प्रवालकम् ।
 नीरसम्² अधरेसीमा शिखरं शिखरोद्भवम् ॥ ८४ ॥
 वर्णदं विवरं चैव शैवेयं³ च विभूषणम् ।
 विद्रुमस्येतन्नामानि⁴ कार्यकाले प्रयोजयेत् ॥ ८५ ॥
 कूर्मकं कूर्मकं चैव कमठपृष्ठं सकालकम् ।
 कमठं कर्कशं चैव कलिङ्गजातं⁵ माशुभम् ॥ ८६ ॥
 कचकं कङ्कडुः⁶ कर्म लोके कचकटं तथा ।
 एतानि कूर्मपृष्ठस्य नामानि च विशेषतः ॥ ८७ ॥
 शङ्खं च जलजं चैव देववादित्रमेव च ।
 विष्णुवज्रभक्तं⁷ चैव सोमदेवतकं शुभम् ॥ ८८ ॥

- (1) A reads विद्रुमे वरदं. B reads विद्रुमे वरदे.
- (2) A reads नीरसे.
- (3) A and B read शैवेयं.
- (4) A has विद्रुमेनावि. B has विद्रुमेनानि. Both are incorrect.
- (5) कलिङ्गजातं is an incomplete variant in A and B.
- (6) A has कचककङ्कडुः. B has कचकङ्कडुः.
- (7) B reads erroneously विष्णुवज्रभक्तं.

वरायुधं च वरदं शुभ्रं माङ्गल्यदायकम् ।
 भजेयं सर्व्वजन्तूनां दानवास्त्रि वरोदयम्^१ ॥ ८८ ॥
 गम्भीरं घोषशब्दं च पवित्रं पारदं गृहम् ।
 एतानि^२ शंखनामानि वामदक्षिणकावभौ^३ ॥ १०० ॥
 शक्तिका सीफिका^४ कान्ती मुक्तामाता गरीयसी ।
 चन्द्रपद्मी पयोद्याही संपुटी पटवादिनी ॥ १०१ ॥
 रजताभासिनी दीप्ता वङ्गवारिविशोषणी ।
 पद्मकरीगतिः पद्मगर्भ^५ समुद्रसन्धवा ॥ १०२ ॥
 उत्तमा मध्यमा नीचा त्रिविधा सागरोद्भवा ।
 नद्युद्भवा तु सा नीचा^६ नीचकर्णविशारदा ॥ १०३ ॥

(1) Both A and B read वरं देयं, which destroys both grammar and metre.

(2) A and B read एतत्ते, which is grammatically incorrect.

(3) A reads वामदक्षिणकावभौ. B reads वामदक्षिणकावभौ.

(4) B has only सीफा.

(5) A and B read पद्मेगर्भ

(6) नद्युद्भवा तत्रोद्या, an incomplete variant in A.
 नद्युद्भवा तत्रोद्या, an incorrect and incomplete variant in B.

एतत्तु लक्षणं शक्तेः^१ कर्मकाले प्रयोजयेत्^२ ।
 ज्ञात्वा यः कुरुते कर्म सिद्धयेत् सकलं फलम् ॥ १०४ ॥
 गजोद्भवं रदं^३ दन्तं द्विजं चैव तु पुष्पकम् ।
 नारीसौभाग्यदं चैव गजभूषणसम्पत्तम् ॥ १०५ ॥
 तैलरक्षाकरं श्रीदं संपुटं पुटिकं तथा ।
 नामानि गजदन्तस्य अन्यानि मध्यमानि च^४ ॥ १०६ ॥
 पिच्छकं कुक्कुटं च व शिखिपिच्छं सुचित्रकम् ।
 हरिमौलिधरं श्रीदं मोहनं चन्द्रकं तथा ॥ १०७ ॥
 नागारिं सर्पदमनं विषदं विषनाशनम् ।
 एतानि शिखिपिच्छस्य नामानि विविधानि च

॥ १०८

(1) A and B read एतत्ते लक्षणा शक्ति, which is an incorrect variant.

(2) कर्मकार्ये प्रयोजने, a variant in A, which seems to be incorrect.

(3) A reads रदं, which is incorrect.

(4) अन्यस्य मध्यमानि च, a variant in A and B, which is grammatically incorrect.

नखं सङ्घटयपुरं^१ धातुकीमलकारणम्^२ ।
 वज्रं^३ दुर्गन्धिकं चैव तुरीटापस्तु बोभकम्^४ ॥१०८॥
 कचं केशं च बालं च मूर्ध्निजालकमेव च ।
 श्मामं चैव घनं प्रोक्तं कर्कशं नर्मदं लघु ॥ ११० ॥
 एतानि धातुनामानि यथाकर्माभिधानकम् ।
 ज्ञात्वा भारभ्यते कर्मा स्वस्थे सिद्धिः प्रजायते ॥१११॥
 पार्श्वत्युवाच ।
 शम्भो शङ्कर विष्णेश विष्णुनाथ जगद्गुरो ।
 श्रुतानि चैव नामानि स्थानानि कथ्यन्तां^५ प्रभो ॥११२॥

(1) न ङ्घटयपुरं, a variant in A- न ङ्घटयपुरं, a variant in B. Both are incorrect.

(2) B reads कारकं.

(3) B reads वज्रं, which is not correct.

(4) A reads तुरीटापस्तुबोभकं.

(5) A and B read कथ्यन्तां, which is grammatically incorrect.

महादेव उवाच ।

शृणु देवि प्रयत्नेन स्थानानि विविधानि च ।

सुवर्णस्योदयो धातोः सर्व्वस्थापकपर्व्वते^१ ॥ ११३ ॥

पार्थिव्यं हि च तत् सर्व्वे^२ मृदामध्यात् प्रजायते ।

तस्मात् स्थानस्य संक्षेपः श्रूयतां सादरं^३ शुभे ॥ ११४ ॥

हेमं च प्रथमं कल्पं मेरुमध्ये सदैव हि ।

दुर्लभं मर्त्यलोकेषु कष्टेनैव तु लभ्यते ॥ ११५ ॥

पुनर्हेमाद्रिणा तेन जायते सर्व्वदा शुभे ।

महाशैतल्लते^४ तेन दुर्लभं स्यात् सदैव हि^५ ॥ ११६ ॥

पश्चात्पश्चूनदोद्भूतं जम्बूद्वीपेषु जायते ।

तच्च कष्टतरं मन्ये दुर्लभं तत् सदैव हि ॥ ११७ ॥

(1) A reads वत्तीत. B reads पत्तीत. Both the readings are incorrect.

(2) पार्थिव्यानि च ते सर्व्वे, an incorrect variant in A and B.

(3) A and B read सादरात् which is incorrect.

(4) A reads महत्शैतल्लते, which is incorrect.

(5) B reads सदैव हि, which is incorrect.

पृथिव्यां धातुमध्येषु सर्वेषामधिकं सदा ।
 लोहाधिकतरं तत्र ज्ञातव्यं सर्व्वदा शुभे ॥ ११८ ॥
 कष्टे निःसारणं तेषां मौल्यादधिकं जायते ।
 तस्मात्तेनैव यत्नेन साधनं क्रियते नरैः^१ ॥ ११९ ॥
 असाध्यसाधनं तस्य जातं सर्व्वयुगे शुभे ।
 तस्मात्तु^२ बहुमूख्येन सर्व्वधातूपरिस्थितिः^३ ॥ १२० ॥
 पुनः स्थानं कृतं तेन लङ्कायां च सदैव हि ।
 उद्धृतं तेन यत्नेन मर्त्तादु^४भौतं मया शुभे ॥ १२१ ॥
 पार्व्वत्युवाच ।
 महारुद्र शङ्कर श्रीमन्^५ लोकनाथ जगत्पते ।
 कथं ते मानुषे भौतिः^६ कथ्यतां परमेश्वर ॥ १२२ ॥

(1) A has कृतं नराः. B has ज्ञयते नराः. Both are incorrect.

(2) A and B read तस्मात्ते, which is incorrect.

(3) सर्व्वधातूपरिस्थितिः, an incorrect variant in A and B.

(4) A and B read erroneously चत्वारः.

(5) श्रीमान्, a reading in A and B, is not correct.

(6) मानुषादुभौतिः is the correct form.

महादेव उवाच ।

सुवर्णस्यैषा महती^१ भीतिर्मानुषसम्भवा ।

उच्चो नीचपदं सम्यक् जायते बहुलै रतिः ॥ १२३ ॥

मया मानुषभीतेन^२ उद्धितं सादरेण च ।

दुर्लभं च विशेषेण प्राक् कलियुगे इदम्^३ ॥ १२४ ॥

पार्थिव्युवाच ।

मदाय मानस नाथ जाताऽसा सशया महान् ।

भवतां मानुषी भीतिः कथं तु जगदीश्वर^४ ॥ १२५ ॥

महादेव उवाच ।

कारणं वर्तते देवि अख्याख्येयं सदेव हि ।

कथनीयं त्वयि भद्रे यत्तत्त्वं^५ मम वल्लभा ॥ १२६ ॥

(1) A and B read सुवर्णस्यैषा महती, which is not correct.

(2) मां च मानुषीभीतेन, an incorrect variant in A and B.

(3) A and B read इमे. This foot is incomplete.

(4) A reads कथं ते जगदीश्वर. B reads कथं ते जगदीश्वरः.

Both are incorrect.

(5) यत्तत्त्वं is an incorrect variant in A and B.

तुष्टिचतुरतावृष्टिर्जायते च कलौ युगे ।

मानुषे च भवतीह^१ मम क्षोभानुवर्त्तिनी ॥ १२७ ॥

तस्मात्तैर्वहुले^२ द्रव्ये साध्यते गन्धकी क्रिया ।

अथवा पारदी चैव मम क्षोभानुवर्त्तिनी ॥ १२८ ॥

पार्वत्यवाच ।

श्रुता सा गन्धकी विद्या सर्वसौभाग्यदायिनी ।

सङ्गभक्षता सा च^३ न सिध्यति गरीयसी ॥ १२९ ॥

भवता पूर्वमुक्तं हि सङ्गभक्षणयोगतः ।

न सिध्यति च ते विद्या सदा गन्धकपारदी ॥ १३० ॥

तस्मात्तु कथ्यतां देव मनो^४ब्धानिविवर्जितम् ।

सुवर्णसाधिनीं विद्यां^५ तस्माद्वदतु मे विभो ॥ १३१ ॥

(1) A and B read भवतीह, which is not correct.

(2) A and B read तस्मात्ते, which is incorrect.

(3) A and B read ते च.

(4) A reads मन.

(5) A and B read सुवर्णसाधिनी विद्या.

महादेव उवाच ।

मानसं मदीयं देवि जातं सम्यक् सुनिर्मलम् ।
 तथापि मानुषे भौतिर्विद्या¹ गन्धकपारदी ॥१३२॥
 सङ्गभक्षणजं कष्टम्² उभे मेलापनं महत् ।
 सुष्ठु मग्नव्रते वक्त्रौ ज्वलते तत्क्षणात् ततः ॥१३३॥
 मग्नवत् साधयेद्विद्यां साधयेद्यज्ञतः क्रमात् ।
 तस्मात्तेनैव महता गोप्या-सिद्धिकरी क्रिया ॥१३४॥
 पार्वत्युवाच ।

पुरा प्रोक्तं त्वया नाथ पटले पञ्चदशके³ ।
 कैलासात् परमं सौख्यं भजते मग्नविष्णुनः ॥१३५॥
 क्रिया गन्धकिनी⁴ मध्ये अथवा पारदी शुभे ।
 कैलासादधिकं सौख्यं भुञ्जते विधिवन्तराः⁵ ॥१३६॥

- (1) A and B read विषे, which is senseless.
- (2) A and B have वाहं, which is incorrect.
- (3) पटले पञ्चादिके, a variant in A and B, which is incomplete.
- (4) A and B read गन्धकिनी.
- (5) A and B read नरः, which is incorrect.

महादेव उवाच ।

निर्मलं मानसं जातं तव वाक्यविमोहितम् ।

कथयामास ते भद्रे गुणलक्षणसंयुतम्¹ ॥ १३७ ॥

स्वर्णीत्पत्तिस्थलं² नित्यं सर्व्वत्रापि विधीयते ।

उत्पादनगतिस्तस्य स्थाने स्थाने पृथक् पृथक् ॥ १३८ ॥

अयतां वरदे देवि स्थानं चैव यथोदितम् ।

तस्य वातोत्थजा रेणुधमने स्वर्णं³ जायते ॥ १३९ ॥

पावकाद्रेभुवावाहुः⁴ समरद्वाकरे तथा ।

समुद्रस्य तटे दिव्ये स्थानं स्यात् स्वर्णकस्य च ॥ १४० ॥

स्वल्पं च सिन्धुदेशेन कामरूपैस्तथैव च ।

अन्यैस्तु विविधैः स्थानैः साम्प्रतोत्पत्तिर्जायते ॥ १४१ ॥

(1) A and B read संयुतः, which is not accurate.

(2) Both A and B read स्वर्णीत्पत्तिः स्वर्णं, which is not correct.

(3) A and B add च after स्वर्णे.

(4) A reads पावकाद्रस्य भुवावाहुः. B reads पावकाद्रस्य भुवावाहुः.

तत्र तत्रोत्पत्तिस्तेषां यत्र यत्र हिमद्रवः ।
 प्रसरन्ति भुवि संघाः¹ संशयो नास्ति ते सदा ॥ १४२ ॥
 ताम्रोत्पत्तिश्च महता सुखेनैव प्रजायते ।
 तेषां स्थानानि वक्ष्येऽहं² याथातथ्येन च नृणः³ ॥ १४३ ॥
 नेपाले कामरूपे च⁴ वङ्गले मदनेश्वर⁵ ।
 गङ्गाहारे मलादौ च ज्येष्ठदेशे तथैव च ॥ १४४ ॥
 पावकादौ जीर्णदुर्गे रुमदेशे फिरङ्गके ।
 एतान्युदितस्थानानि⁶ सर्व्वपर्व्वतके⁷ सदा ॥ १४५ ॥
 आसत्त्वं यस्तु⁸ दिव्यं हि स्थानानि तस्य च नृणु ।
 कुम्भाद्रावथ⁹ काम्बोजे रुमदेशे बलवति ॥ १४६ ॥

- (1) चने is the variant in A. चने is the variant in B.
- (2) स्थानान् प्रवक्ष्येहं is the incorrect variant in A and B.
- (3) A and B read ते यत्र.
- (4) नेपालं कामरूपं च, a reading in A and B.
- (5) वङ्गाचं मदनेश्वरं, a variant in A and B.
- (6) एतानि उदितस्थानानि, an incorrect variant in A.
- (7) A and B read उपर्व्वतके, which is incorrect.
- (8) A and B read वत्ते.
- (9) A and B read कुम्भादेश, which is incorrect.

एतान्भयोः स्नानानि^१ रजःस्नानं च^२ उच्यते ।

जासत्वं वङ्गले नागं नेपाले च सदैव हि ॥ १४७ ॥

केदारं कर्मकाण्डे च त्र्यम्बके त्रिपुरे तथा ।

एतत्स्नानानि दिव्यानि^३ गोप्यान्यन्यानि

तानि ह^४ ॥ १४८ ॥

लोहाद्रौ^५ लोहस्तत्कर्म गयाद्रौ^६ गौतमाद्रिके^७ ।

विन्ध्यमध्ये^८ हि सर्व्वे च नलाद्रौ^९ निष्कलेऽपि वा

॥ १४९ ॥

(1) एति उभयोः स्नानात्, a reading in A. एति उभयोः स्नानात्, a reading in B.

(2) A and B read रजस्नानानि.

(3) A and B read स्नानानि दिव्यान्.

(4) चन्वा गोप्वा तितेति ह, a variant in A and B, which is senseless.

(5) A and B read लोहाद्रे, which is incorrect.

(6) Do. Do. नलाद्रे, Do.

(7) Do. Do. गौतमाद्रिके, Do.

(8) Do. Do. विन्ध्यमध्ये, Do.

(9) Do. Do. नलाद्रे, Do.

अग्न्यके विमले¹ चैव लोहाकशालिवाहने ।

समुद्रस्य तटे रम्ये आद्ये अन्ते च मध्यगे ॥ १५० ॥

लोहस्यैतानि स्थानानि² हाटकैश्च³ सदैव हि ।

किञ्चित्⁴ गोप्यानि दिव्यानि संस्कारैः रक्षितानि च⁵

॥ १५१ ॥

युक्ते तु संस्कृते तेषु स्वर्णी सिद्धिः प्रजायते ।

अयुक्ते नैव लभ्या तु⁶ युक्ते प्राप्तिः सदैव हि ॥ १५२ ॥

पारदे गन्धके धात्वोः योग औषधकृत्⁷ सदा ।

मानसे निर्मले चैव लभ्यते⁸ हाटकी क्रिया ॥ १५३ ॥

(1) A reads विमले.

(2) लोहस्यैतानि च स्थानात्, a variant in A and B, which is incorrect.

(3) A reads हाटके च.

(4) केचित् is the reading in A and B, which is incorrect.

(5) A reads से. B reads ते.

(6) A and B read लभ्यते, which is not correct.

(7) Do. Do. औषधीयकृत्, Dg.

(8) Do. Do. लभ्यते, Do.

अन्यथा नैव लभ्या तु¹ विना मन्त्रेण सिध्यति ।
 तस्मादेवं² प्रयत्नेन निर्मलं मानसं शुभम् ॥ १५४ ॥
 अशुभं समलं चैव मानसं सर्वदा भवेत् ।
 तस्मात्तु चतुराहारे³ सर्वदा शुभमानसः ॥ १५५ ॥
 जायते च क्रिया सिद्धा हाटकौ भवति सर्वदा ।
 मन्त्रसिद्धिः प्रजायेत सर्वकर्मणि साधयेत् ॥ १५६ ॥
 अनेनैव प्रकारेण उत्तमा हाटकौ क्रिया ।
 सर्वकार्यकरी नृणां चतुर्वर्गफलप्रदा ॥ १५७ ॥

महादेव उवाच ।

प्रोक्तसंपुटके चैव स्थूलकाचीयकेन च ।
 उष्णाङ्गारकते अग्नी⁴ सुमरं छागरेकजम् ॥ ८

- (1) A and B read लभ्यते, which is not correct.
- (2) A and B read तस्मादेवं, which is not correct.
- (3) A reads चतुराहारे, which is unintelligible.
- (4) A reads हतेरपि. B reads चतेरपि.

खर्पराख्ये पुटे चैव चारख्योत्पलकेन च ।
 साङ्गं विनास्त्रि(?)गति च ज्वलिते चर्चमर्चगे^१ ॥ १० ॥
 एवानुक्रमतो योगे पुटमेकं च जायते ।
 चतुरंशेन जासत्वं सुवर्णाहापयेत् सुधीः ॥ ११ ॥
 प्रति संपुटपुटे चैव उद्धयेत् कुण्डखर्परे ।
 स्वाङ्गशौतं^२ समुद्धृत्य लेपसुत्तारयेत्ततः^३ ॥ १२ ॥
 पुनर्लेपः प्रदातव्यः^४ पुनः चारान् प्रदापयेत् ।
 पुनरेव घोटनं देयं सादरं पुनरेव हि ॥ १३ ॥
 चनेनैव प्रकारेण तुर्थांशसंपुटेन हि ।
 सुवर्णसंयुतं तच्च^५ गालयेत् चारसंयुतम् ॥ १४ ॥
 ज्वलिते तोलयत्येव तिलाङ्गं संपुटं प्रति ।
 नञ्जीभूतं च रक्षेयं संस्कारैः शुध्य साम्प्रतम् ॥ १५ ॥

(1) A and B read ज्वलितेरर्चमर्चगे.

(2) ज्ञानशौतेन is the reading in A and B, which is not accurate.

(3) A and B read चैवसुत्तारयेत्ततः, which is incorrect.

(4) A and B read पुनर्लेपं प्रदातव्यं, which is not correct.

(5) A and B read हि च, which is incorrect.

एतत्क्रमक्रमेणैव सुवर्ण^१मनुसञ्चय ।
 तद्गुणे शोषिभाषीते महत्ततः प्रजायते ॥ १६ ॥
 आरत्नं पीतसंयुक्तं जायते हाटकं महत् ।
 हाटकं मत्तकं^२ चैव न च ह्रीनेन योजयेत् ॥ १७ ॥
 कलागुणगते वृद्धिर्जायते उत्तमे नरे^३ ।
 अनेनैव प्रकारेण मात्राद्विगुणं दापयेत् ॥ १८ ॥
 कलात्रय^४मिति वृद्धिर्दापिता वृद्धिरिष्यते ।
 निर्दोषं जायते दिव्यं द्रव्यसंपत्तिदायकम् ॥ १९ ॥

पार्वत्युवाच ।

अधिकेन कृते तत्र^५ शोषपाने सुशोभने ।
 जायते कोट्यंशं देव संयोगे अधिके सति ॥ २० ॥

- (1) A and B read सुवर्णान्, which is not correct.
- (2) A and B read हाटके मत्तके चैव.
- (3) उत्तमो नरः, a variant in A and B.
- (4) A and B have कलात्रयं.
- (5) A and B have ते च, which is incorrect.

महादेव उवाच ।

शोणपाने च संयोगे भङ्गदः अस्ति¹ निश्चयः ।
 द्विगुण² शोणपानेन कलंकं जायतेऽशुभम्³ ॥ २१ ॥
 वेधसंगं सुधनार्थं त्रिंशंशे दिक्पलोपमम् ।
 अतिरिक्तकृतं तच्च जायते सगुणं महत् ॥ २२ ॥
 गालयेद्यज्ञपूर्वेषु छायेद्रससमांशके ।
 समांशे गन्धकं देयं शुद्धं पीतक⁴ रागकम् ॥ २३ ॥
 चयतुर्थ्यांशकं तालं दापयेद्रसमोदितम् ।
 तद्वर्द्धं सादरं देयं मर्द्दयेत् कन्धकारसे ॥ २४ ॥
 यामत्रितयमामर्द्द⁵ छायाशुष्कमण्डजे रसे ।
 अतिशुष्वेतरं सुप्ते अथवा सोहसंभवे ॥ २५ ॥

- (1) A and B read भङ्गदा अस्ति, which is incorrect.
- (2) Do. द्विगुणे.
- (3) Do. शुभं, which appears to be incorrect.
- (4) Do. पीतक, which is senseless
- (5) यामत्रितयमामच, an incomplete variant in A and

B.

मर्द्दयेद्यद्गन्धपूर्वेषु छायाशोषितं कारयेत् ।
 काचकूप्ये प्रदातव्यं^१ वज्रिर्वालुङ्गयन्मगः^२ ॥ २६ ॥
 नखसंख्यामिते यामे पाचयेद्रसं शोभने ।
 स्वाङ्गशोते तु संजाते पुनः खले निधापयेत् ॥ २७ ॥
 रसेनानेन आमर्द्दय छायाशोषितं कारयेत् ।
 उक्तयामे रसे^३ दत्ते पुनः शोषं^४ प्रदापयेत् ॥ २८ ॥
 उक्ताग्नी दापयत्येव पुनः संस्कारमाचरेत् ।
 संस्कारे त्रिविधे जाते अग्निपूर्व्वे क्रमोदिते ॥ २९ ॥
 जायते रसराजोऽसौ सर्व्वसामर्थ्यदायकः ।
 संचयेत्तण्डुलार्द्धस्तु अतिविक्रमवेगवान् ॥ ३० ॥
 जायते प्रबला बुद्धिः त्रिदिने सेवते यदि^५ ।
 सार्द्धवृद्धिक्रमेनैव दिने मासफलं सदा ॥ ३१ ॥

(1) प्रदातव्या, a reading in A and B.

(2) यन्मगा, a reading in A and B.

(3) रसी is the variant in A and B.

(4) शोषे is the incorrect reading in A and B.

(5) A and B read सेवनेत्यपि, which is grammatically incorrect.

जायते नात्र सन्देहः सिद्धिर्गन्धकसम्भवा ।

अनेनैव प्रकारेण रससिद्धिः प्रजायते ॥ ३२ ॥

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पार्ष्वल्युवाच ।

श्वेतता कर्मणा केन^१ जायते रजतेषु च ।

क्रमेण राजतौ सिद्धिः पश्चाद्वाटकसम्भवा ॥ ३८ ॥

महादेव उवाच ।

अथानन्तरता विद्या धातुसंस्कारकारिणी ।

जासत्वे^२ कठिने जाते शुद्धे कीमलकारिणी ॥ ३९ ॥

तथाच पीतशुक्लेषु जायते शुद्धनम्रता ।

शुक्लं यत्ने क्रिया दिव्याः शुद्धजासत्त्वसम्भवाः ॥ ४० ॥

पिष्टं हयसुरोत्थं च द्विगुणं धातुतः सदा ।

अर्द्धन्तु दापयेत् स्नावे अर्द्धं निम्ने च^३ रक्षयेत् ॥ ४१ ॥

(1) केन कर्मण, an incorrect variant in A and B.

(2) जासत्वे is the reading in A and B, which is not correct.

(3) A and B read निम्ने.

निर्मलं धातुजं द्रावं सावधूर्णेन ढालयेत् ।
 यदर्घं च स्त्रितं निम्नं तत्कालं दापयेत् सुधीः ॥४२॥
 उपरि संपुटं देयं समुद्रकुङ्कुटे पुटे^१ ।
 स्वाङ्गशीतं समुद्धृत्य जायते निर्मलं महत् ॥ ४३ ॥
 जासत्वे सोमलं देयम् उक्तभागेन^२ साम्प्रतम् ।
 चूर्णान्तरगतं कृत्वा उज्ज्वलं जायते महत् ॥ ४४ ॥
 तदेव^३ जासत्वं चैव दिव्यम् उज्ज्वलगं सदा ।
 रूप्यार्धे मेलयत्येव जायते शुद्धता शुभा ॥ ४५ ॥
 अनेनैव प्रकारेण धनं किञ्चिच्च जायते ।
 धने चैव तु संजाते कारयेद्दूर्ध्वाः क्रियाः ॥ ४६ ॥

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अतीव शोभना विद्या रसगन्धकजा सदा ।
 अतिसौभाग्यदा सा^४ च साधके सुखदायिका ॥४७॥

(1) समुद्रं कुङ्कुटे पुटे, a variant in A and B, which seems to be incorrect.

(2) उक्तभागेन, a variant in A and B.

(3) A and B read स एव, which is not correct.

(4) Do. ते Do.

एतादृशं च जासत्वं शोधितं गन्धकेन च ।
 धालघौतेन ताम्रेण पुञ्जितं^१ सुभगं सदा ॥ ६८ ॥
 पुञ्जितं जायते दिव्यं शुक्लपीतं शुभोदितम् ।
 निर्मलं जायते तच्च हीनहाटकसन्निभम् ॥ ६९ ॥
 लघुता जायते तस्य किञ्चिन्नार्या गुरुता सदा ।
 जायते गुरुता दिव्या पुञ्जिते हाटकेन च ॥ ७० ॥

२८ श-पटलादुद्धृताः श्लोकाः ।

पार्वत्यवाच ।

पूर्वमुक्तं त्वया नाथ धने सिद्धिस्तु जायते ।
 लघुद्रवकृते धातौ^२ वद^३ किं तत्र सुज्यते ॥ ४३ ॥

महादेव उवाच ।

क्रिया चम्नेः शुभा तेषां द्रव्यसिद्धिविधायिनी ।
 नृणु यत्नेन तां भद्रे क्रियां रंगीति नागजाम् ॥ ४४ ॥

(1) A and B read पुंजिते.

(2) A and B read जाते, which is incorrect.

(3) A reads वच. B reads वचः.

आनयेत् पारदं दिव्यम् अधजर्ज्विपातितम् ।
 क्षालयेद्यत्नपूर्व्वेण खले पिष्टं तु कारयेत् ॥ ४५ ॥
 तैलेनानेन आमर्द्दय भावना क्षणमात्रतः ।
 निम्ने डमरुके यन्त्रे अग्निं दद्याद्विचक्षणः ॥ ४६ ॥
 उत्थयेद्यामयुग्मेन स्वाङ्गशीतं समुद्धरेत् ।
 पुनः समाननागेन पूर्व्ववत् क्षालयेत् सुधौः ॥ ४७ ॥
 पुनरेव हठादग्नौ उत्तयामेन सिद्धयति ।
 रसे द्विवारके चैव ह्रीनहेमोत्तमोत्तमः^१ ॥ ४८ ॥
 तैलिके रक्तिकायुग्मं दापिते वर्णपञ्चकम्^२ ।
 अनेनैव प्रकारेण जायन्ते षोडश कलाः ॥ ४९ ॥
 द्रव्यहृदिकरं तच्च जायते नात्र संशयः ।
 पुनरेव क्रिया रम्या पारदे नागचारिणी ॥ ५० ॥
 द्विगुणे चारिते तत्र^३ जायते चन्द्रिका शुभा ।
 आभासेन शिखिघ्नीवा जायते नात्र संशयः ॥ ५१ ॥

(1) ह्रीनहेमोत्तमः, an incomplete variant in A.

(2) पञ्चकः is the reading in A and B, which is incorrect.

(3) ते च is the incorrect reading in A and B.

पुष्पिते हीनहिमेन जायते क्रयविक्रयः ।
 अनेनैव प्रकारेण जायते धनसंपदः ॥ ५२ ॥
 अतज्ज्ञं क्रिया या च^१ विद्या नागस्य संभवा ।
 रसे तु नागजे चैव विधिनानेन वर्त्तते ॥ ५३ ॥
 तायते^२ सकला विद्या नागतैलस्य संभवा ।
 सर्व्या सा^३ शोभना विद्या तीव्रदारिद्र्यनाशिनी ॥ ५४ ॥
 अथातः संप्रवक्ष्यामि त्रपूणां विधिसुत्तमम्^४ ।
 येन विज्ञानमात्रेण जायते रजतं महत् ॥ ५५ ॥
 अनेका राजती सिद्धिः जायते परमोत्तमा ।
 जायते धनसिद्धिश्च^५ जायते नात्र संशयः ॥ ५६ ॥

(1) A and B read ये च, which is incorrect.

(2) A and B have ताते, which is incomplete.

(3) A and B have ता, which is not correct.

(4) A and B have विधिदत्तमा, which is grammatically incorrect.

(5) A and B have स्मात् instead of च, which is a tautology.

पार्ष्वत्यवाच ।

वद वैभवदातारं^१ वङ्गं विज्ञानदायकम्^२ ।

ज्ञात्वा सिद्धिमवाप्नोति गुणत्रैः सौख्यकं च यम् ॥५७॥

महादेव उवाच ।

आनयेच्छोभनं वङ्गं विख्याचलसमुद्भवम् ।

गालयेद्यत्नपूर्व्वेण ढालेत् क्षाण्डजे रसे ॥ ५८ ॥

त्रिःसप्तककृते तच्च^३ जायते निर्मलं शुभम् ।

तदुत्थान् कारयेत् पचान्^४ शुचिविज्ञानं यथोदितान्

॥ ५९ ॥

रक्षयेद्यत्नपूर्व्वेण आनयेद्वर्किकं^५ पयः ।

भावयेत् शुक्तिकाचूर्णम् उज्ज्वलं वङ्गिशोधितम् ॥६०॥

(1) दाता च, a variant in A and B.

(2) दायकः, a variant in A and B.

(3) ते च is the incorrect variant in A and B.

(4) A and B read तदीयान्, which is incorrect. The word पत्र is used here in the masculine gender.

(5) B reads वद्विषं.

मर्ह्येद्यन्नपूर्वेषु यावन्नेपः सुलक्षते¹ ।
 यवाहं लेपयत्येव पत्रान् तु यन्नपूर्वेष्वम् ॥ ६१ ॥
 छायाशुष्के च संजाते दापयेच्छुक्तिसंपुटे ।
 चूडाघो लेपयत्येव सन्धो यन्नेन सुदयेत् ॥ ६२ ॥
 मेलितौ माषगोधूमौ पिष्टलेपं प्रदापयेत् ।
 छायाशुष्के च संजाते मृन्मयं लेपं दापयेत् ॥ ६३ ॥
 सुशुष्के च² गजे पाच्यं स्वाङ्गशीतं³ समुदरेत् ।
 जायते उज्ज्वलं वक्त्रं वातशुष्कं तु कारयेत् ॥ ६४ ॥
 यः कश्चित् मूर्च्छितश्चैव⁴ जीवयेज्जीवनक्रियाम् ।
 स हि वक्त्राग्रयेणैव⁵ उज्ज्वलः कठिनो⁶ भवेत् ॥ ६५ ॥

(1) यावन्नेपस्य लक्षते, a variant, which seems to be incorrect.

(2) सुशुष्केन, a variant in A and B.

(3) स्वाङ्गशीते, a variant in A and B.

(4) ये कश्चित् मूर्च्छिते ते च, an incorrect variant in A and B.

(5) सङ्गवर्णाद्येत्येव, a variant in A and B, which is unintelligible.

(6) A and B read उज्ज्वलं कठिनं, which is incorrect.

अतिशुद्धतरं तच्च जायते नात्र संशयः ।
 सर्व्वकार्मिकरं श्रेष्ठं नानाभागेन पुञ्जितम् ॥ ६६ ॥
 भोगभागसमायुक्तं वङ्गं च गुणसंयुतम् ।
 लक्षणार्थे^१ धनार्थे च^२ संयोगे साधयेत् सदा ॥ ६७ ॥
 जायते सुभगं तच्च संसारे शोभनं भवेत् ।
 अनेनैव प्रकारेण जायन्ते धनसम्पदः^३ ॥ ६८ ॥

पार्व्वत्युवाच ।

अपौ शुद्धतरं जाते का क्रिया वद मे विभो ।
 लक्षणार्थं धनसंपत्तेः क्रिया या च पृथक् पृथक् ॥ ६९ ॥

महादेव उवाच ।

लक्षणेन^४ च नारीणां भिक्षा भिक्षेन वर्त्तते ।
 अनेका धनदा विद्या जायते सुभगा महत् ॥ ७० ॥
 अतीव शोभना सा च गुणसामर्थ्यदायिका ।
 येन विज्ञानमात्रेण साधके धनमुत्तमम् ॥ ७१ ॥

- (1) B reads भक्षणार्थे.
- (2) धनार्थे is omitted in B.
- (3) जायते धनसंपदा, a variant in A and B.
- (4) A and B read भक्षणेन.

जायते नैव सन्देहो धनसामर्थ्यकं महत् ।
 अतिसौभाग्यसम्पत्तिर्जायते नात्र संशयः ॥ ७२ ॥
 आनयेत् शुद्धं तं वङ्गं गालयेत् टङ्गणैः सह ।
 पिष्ट्वाकसुरसे दिव्ये ढालयेद्यत्नपूर्वकम् ॥ ७३ ॥
 सप्तढालकृते शुद्धे कठिनं रजतोपमम् ।
 जायते नैव सन्देहः पुष्पिते रजते शुभे ॥ ७४ ॥
 रजतं जायते शुद्धं संभारं कारयेत् सुधीः ।
 अन्येष्वेव विधिर्दिव्यो दिव्यरजतसंभवः^१ ॥ ७५ ॥
 आनयेत् शोधितं वङ्गं तद्वर्धे पारदे छलेत् ।
 निधाय^२ शोभने खले तुर्यांशे दापयेत्ततः ॥ ७६ ॥
 मर्हयेत् कन्यकावीर्यं यामं षोडश यत्नतः ।
 हंसपद्मा रसे दिव्ये तत्समं मर्हयेत् सुधीः ॥ ७७ ॥
 समाना^३ रसेनैव मर्हयेद्यत्नपूर्वकम्^४ ।
 छायाशुष्के च^५ संजाते शोषान्ते^५ बालुके पचेत् ॥ ७८ ॥

(1) दिव्यादिव्यं रजतसंभवा, a variant in A and B.

(2) A and B read निधाय or निधाय.

(3) यत्नपूर्वकः, a variant in A and B.

(4) छायाशुष्के, a variant in A and B.

(5) A reads शोषान्ते. B reads शीघ्रान्ते.

अग्नेनेव प्रकारेण क्रमादग्निं प्रदापयेत् ।
 प्रह्वराष्टकेऽष्टकेनैव त्रिवारं हठं दापयेत् ॥ ७८ ॥
 जायते च रसं दिव्यं भक्षणे च सुधासमम् ।
 नारीणां दापयेद्यत्ने संयोगे नागकेसरैः^१ ॥ ८० ॥
 तदर्घ्याः सुष्ठु^२ गोधूमाः सहैवं तोलकार्षम् ।
 अतिसौख्यकरं तच्च^३ रक्तिमात्रार्घं वर्धते ॥ ८१ ॥
 पुंसि अजगुणोपेते यथा च गंधकी गतिः ।
 नरार्थं भक्षणे यातो जातित्रयसमन्वितः ॥ ८२ ॥
 अग्नेनेव प्रकारेण क्रमेण वर्धयेद्रसम् ।
 जायते रसजा सिद्धिः नात्र कार्या विचारणा ॥ ८३ ॥
 सुकृत् सुधाकरं वज्रं गालयेद्यत्नपूर्वकम् ।
 तज्जलं शोषयत्येव शतांशे रसदापिते ॥ ८४ ॥
 रजतं जायते शुद्धं कलाद्यात्रिंशतः स्फुटम् ।
 अन्यं वै मेलयत्येव विक्रये शुभदं महत् ॥ ८५ ॥

(1) A reads नागकेसरै.

(2) B reads विषु.

(3) A and B read ते च, which is incorrect.

अनेनेव प्रकारेण जायते धनसंपदः ।
 साधयेत् सिद्धिदा विद्या देहसामर्थ्यायिनी ॥८६॥
 मिसयेद्भोगभागेन महं नाहरदो विधिः ।
 पीते भावनया अम्बो^१ सार्धं हवेन सिद्धयेत् ॥ ८७ ॥
 शुद्धताम्रे प्रदातव्यं अतांशे चाटकोत्तमम् ।
 जायते नाच सन्देहो यथा जाम्बूनदीप्पवम् ॥ ८८ ॥

* * * *

पार्वत्युवाच ।

ताम्रं च तुल्यजं दिव्यं जायते केन विक्रियाम् ।
 वद विष्णेश्वर शम्भो सिद्धिं ताम्रविधानकीम्^२ ॥ ८९ ॥

महादेव उवाच ।

नृक्ष शुद्धक्रियां दिव्यां तुल्यताम्रस्य सम्भवाम् ।
 येन विज्ञानमात्रेण साधयेद्द्रसकुम्भिकाम् ॥ ९० ॥
 साधयेत् पञ्चानृतं दिव्यं महासौख्यप्रदायकम् ।
 ज्ञात्वा कालेन लीयेत संसारसुखभाजने ॥ ९१ ॥

(1) A and B read रघौ, which is incorrect.

(2) सिद्धा ताम्रविधानकं, an incorrect variant in A and B.

पानयेत्तत्त्यक्तं दिव्यं पीतगन्धकसम्भवम् ।

दापयेच्छोभने खल्ले भर्कक्षीरेण भावयेत् ॥ ६७ ॥

मईयेदयन्नपूर्व्येण याममात्रमखण्डितम्^१ ।

तेनैव धातुयोगेन सुवर्णे^२ सुलभतां व्रजेत् ॥ ६८ ॥

एतादृशी परा धातुर्वर्त्तते धातुर्मध्यमा ।

सुलभा शुभदा प्रोक्ता मम सान्निध्यगा सदा ॥ ६९ ॥

पार्वत्युवाच ।

ये गुणा नागजे ताम्रे वद विश्वस्य वल्लभ ।

प्रयोजनवस्तु शक्यं चतुरेणैव चोदितम् ॥ ७५ ॥

महादेव उवाच ।

अनेका गुणा^३ नागेषु पूर्व्वमुक्ता हि^४ पारदे ।

किञ्चित् शेषतरा ये च शृणु देवि प्रयत्नतः ॥ ८६ ॥

(1) A reads याममात्र मखण्डितः. B reads याममात्रे मखण्डितः.

(2) A and B read सुवर्णः.

(3) अनेकान् गुणान्, a variant in A and B.

(4) मुक्तानि पारदे, an incorrect variant in A and B.

नागस्य सम्भवं ताम्रं मध्ये मिलापनं कृतम् ।
 विभागे तु कृते तच्च^१ जायते कुम्भिका शुभा ॥ ८७ ॥
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 जायते निर्मलं स्वर्णम् उदितं चैव कुम्भिके ॥ ८८ ॥
 विभागे साम्प्रतं दत्त्वा समृतं जायते शुभम् ।
 उक्तकार्यकराद्यैते नाम्नाश्च वचनं मम ॥ ८९ ॥
 तस्मात् साधयते दिव्यं भूनागोद्भवजं शुभम् ।
 अनेका साधयेद्विद्या रससामर्थ्यादयिका ॥ ९० ॥

Colophon in A

इति श्रीरुद्रयामले उमामहेश्वरसंवादे सुवर्णकल्पे
 सुवर्णप्रशंसा नामाध्यायः ।

Colophon in B

इति श्रीरुद्रयामले उमामहेश्वरसंवादे धातुमंजर्यां
 सुवर्णप्रशंसा समाप्ता ।

(1) A and B read ते च, which is incorrect.

Extracts from
SUARNATANTRA
or
SVARNATANTRA.

सुवर्णतन्त्रात् वा स्वर्णतन्त्रात्
उद्धृताः श्लोकाः ।

A = MS. from Benares. *

B = MS. from Ramnákáli's matha, Dacca. †

ओगणेशाय नमः ।

ओराम उवाच ।

देवदेव महादेव ऋद्धिबुद्धि फलप्रद ।

पूर्व्वं संसूचिता ऋद्धौ रसायनपरा परा ॥ १ ॥

यस्याः साधनमात्रेण स्त्राराट्पुण्यो नरो भवेत् ।

तां सिद्धिं वद मे देव यदि त्वं भक्तवत्सलः ॥ २ ॥

* The name of this MS. is सुवर्णतन्त्रम्.

† The name of this MS. is स्वर्णतन्त्रम्.

पूर्व तु कथितं देव रत्नतन्त्रं त्वया मम ।
 गुटिकाः कथिताः पूर्वं सहस्रद्वितयं शिव ॥ ३ ॥
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 धातूनामष्ट कल्पास्तु पूर्वमेव प्रकाशिताः ॥ ४ ॥
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 रत्नानां करणे तन्त्रं पूर्वमेव प्रकाशितम् ॥ ५ ॥
 किन्तु स्वर्णाख्यतन्त्रं तु न मया कथितं प्रभो ।
 कश्यपेन महेशानाभ्यर्दितीऽस्मि महेश्वर ॥ ६ ॥
 भूमिदानं मया दत्तम् ऋषये कश्यपाय वै ।
 कश्यपेन मयि प्रोक्तं भूमिभागं त्वज प्रभो ॥ ७ ॥
 स्थानाय तु महेशान रत्नाम्भिः प्रार्थितो मया ।
 वाणमात्रं स्वलं तेन दत्तं मम महेश्वर ॥ ८ ॥
 स्थानं प्राप्तं महेशान भक्षणं मम नास्ति वै ।
 भक्षणं देहि मे देव यदि पुत्रोऽस्मि शङ्कर ॥ ९ ॥

ईश्वर उवाच ।

मृणु राम प्रवक्ष्यामि रहस्यातिरहस्यकम् ।
 स्वर्णतन्त्राभिधं तन्त्रं कल्परूपेण कथ्यते ॥ १० ॥

तत्राद्यं स्वर्णतन्त्रस्य कल्पं शृणु सुपुत्रक ।
 तैलकन्दामिधः कन्दः सिद्धकन्दः प्रकौर्त्तितः ॥ ११ ॥
 कन्दः कमलवत्तस्य पत्राणि कञ्जवर्ष्णिशो ।
 तथैव तु महत्पत्रं तैलं स्रवति सर्व्वदा ॥ १२ ॥
 जलमध्ये सदा पुत्र त्वार्द्र एव प्रतिष्ठते ।
 विषकन्देति विख्यातो विषाच्च कायनाशनः ॥ १३ ॥
 तैलस्रावी महाकन्दः परितस्तैलवज्जलम् ।
 दशहस्तमिते देशे सरते तैलवज्जनम् ॥ १४ ॥
 महाविषधरः पुत्र तदधो वसति ध्रुवम् ।
 कन्दाधः कन्दच्छायायां नान्यत्र गच्छति प्रिय ॥ १५ ॥
 तत्परीक्षाविधानार्थं कन्दे सूचीं प्रवेशयेत् ।
 सूचीद्रावः क्षणात् पुत्र तत्कन्दन्तु समाहरेत् ॥ १६ ॥
 तत्कन्दं तु समादाय शुद्धसूतं खलेन्निधा ।
 मूषायां निक्षिपेत् तन्तु तत्तैलं तत्र निक्षिपेत् ॥ १७ ॥
 दीप्तान्निं तु महाराम वंशाङ्कुरेण दापयेत् ।
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सप्तधा प्रत्यहं राम त्वेवं विंशद्दिनं भ्रुवम् ।
 हरितालो मृतिमेति निर्धूमो जायते भ्रुवम् ॥ २० ॥
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 तत्सैलं तु समादाय ताम्रद्रावे विनिक्षिपेत् ॥ २२ ॥
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 वङ्गे कांस्ये यदा दद्यात्तदा रौप्यं भवेत् सुत ॥ २३ ॥
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 तत्क्षणात् वेधमायाति दिव्यं भवति काञ्चनम् ॥ २४ ॥*

शंखद्रावस्य भेदान् हि तत्क्षणात् शृणु साम्प्रतम् ।
 लौहद्रावस्तथा ताम्रद्रावश्चैव द्वितीयकः ॥ १ ॥
 शंखद्रावस्तृतीयः स्यात् हस्तालव(?) चतुर्थकः ।
 दन्तद्रावः पञ्चमः स्यात् अश्ववेधौ तु मध्यमः ॥ २ ॥

* The above 24 Slokas are not found in MS. A.

पञ्चानां तु परीक्षा वै कथ्यते शृणु साम्प्रतम् ।
 लौहसूचीं समादाय लौहद्रावे विनिक्षिपेत् ॥ ३ ॥
 तत्क्षणाद्भवतां याति सा सूचौ नात्र संशयः^१ ॥
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 सूचीद्रावो याममात्राद्भवत्येव न संशयः ।
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 वज्रमूषां ततः कृत्वा शुद्धसूतं विनिक्षिपेत् ॥ ७ ॥
 लौहसूचौद्रावरसं तच्च यत्नेन निक्षिपेत् ।
 तत्राग्निं दापयेद्यन्नात् पुनस्तत्र^३ रसं क्षिपेत् ॥ ८ ॥

(1) The above 7 hemistichs are not found in A.

(2) A reads दन्ताधो. B reads दन्ताद्याधो. Both the readings seem to be incorrect; since B has हस्ताद्य चतुर्ध्वः in the 2nd Sloka.

(3) B reads पुनस्तत्र, which is not correct.



स स्रोतो नृततामेति¹ नात्र कार्या विचारणा ।
 अष्टधातुषु तं सूतं दत्त्वा काञ्चनतां व्रजेत् ॥ ८ ॥
 तं सूतं भक्षयेद्यो हि सोऽमरत्वमवाप्नुयात्² ।
 तस्य मूत्रपुरीषेषु शुल्वं³ भवति काञ्चनम् ॥ १० ॥
 ताम्रद्रावप्रयोगं वै शृणु यत्नेन साम्प्रतम् ।
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Colophon in A—इति श्रीसुवर्णतन्त्रे हरपावतीसंवादे
 दुस्यर्शकल्पः द्वितीयः ।

Colophon in B—इति स्वर्णतन्त्रे लोहद्रावादपञ्च-
 फलकल्पो द्वितीयः ।

- (1) B has सा सूची नृतिमाप्नोति.
- (2) A reads स गच्छेदमरत्वतां, which is incorrect.
- (3) B reads तुल्य.
- (4) शुद्धताम्नेषु निक्षिपेत्. a variant in B.

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